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A TRANS-NEPTUNIAN PLANET

On March 13 astronomers throughout the world were informed by telegraph and cable, and the reading public by headlines in the daily papers, of the discovery of an object apparently a part of the solar system and yet more distant from the sun than the planet Neptune. When one remembers that sixty-five years elapsed between the discovery of Uranus and that of Neptune, and that eighty-four years have elapsed since Neptune was discovered, one begins to realize the significance of this announcement. The discovery of Neptune was regarded as "the gratest triumph of mathematical astronomy." Information concerning the new discoverey is, as yet, rather limited. It seems, however, that, in a sense, the circumstances of this event are a repetition of those which led to the former discovery and that the finding of this new planet will invest the year 1930 with a glory similar to that shed upon the year 1846 by the discovery of Neptune.

The suggestion in this case, as in the case of Neptune, of the existence of a more distant object came from certain small residual perturbations in the outer planets. These observed residuals, the known elements of the solar system, and the law of gravitation are the material upon which mathematics is able to work. Adams in England and Leverrier in France applied mathematical theory to data of a similar character during the years just preceding 1846 and came to almost identical conclusions relative to the location and size of the unknown planet, the cause of the observed deviations. Uranus under most favorable conditions is barely visible to the unaided eye. Neptune, whose brightness is equal to that of a star between the eighth and ninth magnitudes, is far below the naked eye vision. The new object, which is of the fifteenth or sixteenth magnitude, could be detected only after a most painstaking search. Great credit, therefore, is due to those who furnished the theoretical work and to those who carried out the practical work which together culminated in a remarkable discovery.

Up to the present time the most authentic account of this epochal event is contained in the circular by Professor V. M. Slipher as follows:

The Discovery of a Solar System Body Apparently Trans-Neptunian

The message sent last night (March 12) to Harvard Observatory for distribution to astronomers read as follows:

"Systematic search begun years ago supplementing Lowell's in-

vestigations for Trans-Neptunian planet has revealed object which since seven weeks has in rate of motion and path consistently conformed to Trans-Neptunian body at approximate distance he assigned. Fifteen magnitude. Position March twelve days three hours GMT was seven seconds of time West from Delta Geminorum, agreeing with Lowell's predicted longitude."

For ease in finding object was referred to Delta Geminorum.
Position March 12.14 G.M.T. R.A. $7^h\ 15^m\ 50^s$ Dec. $22°\ 6'\ 49''$

The finding of this object was a direct result of the search program set going in 1905 by Dr. Lowell in connection with his theoretical work on the dynamical evidence of a planet beyond Neptune. (See *L. O. Memoirs*, Vol. I, No. 1, "A Trans-Neptunian Planet," 1914). The earlier searching work, laborious and uncertain because of the less efficient instrumental means, could be resumed much more effectively early last year with the very efficient new Lawrence Lowell telescope specially designed for this particular problem. Some weeks ago, on plates he made with this instrument, Mr. C. W. Tombaugh, assistant on the staff, using the Blink Comparator, found a very exceptional object, which since has been studied carefully. It has been photographed regularly by Astronomer Lampland with the 42-inch reflector, and also observed visually by Astronomer E. C. Slipher and the writer with the large refractor.

The new object was first recorded on the search plates of January 21 (1930), 23rd, and 29th, and since February 19 it has been followed closely. Besides the numerous plates of it with the new photographic telescope, the object has been recorded on more than a score of plates with the large reflector, by Lampland, who is measuring both series of plates for positions of the object. Its rate of motion he has measured for the available material at intervals between observations with results that appear to place the object outside Neptune's orbit at an indicated distance of about 40 to 43 astronomical units. During the period of more than 7 weeks the object has remained close to the ecliptic; the while it has passed from 12 days after opposition point to within about 20 days of its stationary point. Its rate of retrogression, March 10 to 11, was about 30″ per day. In its apparent path and in its rate of motion it conforms closely to the expected behavior of a Trans-Neptunian body, at about Lowell's predicted distance. There has not been opportunity yet to complete measurements and accurate reductions of positions of the object requisite for use in the computation of the orbit, but it is realized that the orbital elements are much to be desired and this important work is in hand.

In brightness the object is only about 15th magnitude. Examination of it in the large refractor—but without very good seeing conditions—has not revealed certain indication of a planetary disk. Neither in brightness nor apparent size is the object comparable with Neptune. Preliminary attempts at comparative color tests photographically with large reflector and visually with refractor indicate it does not have the blue color of Neptune and Uranus, but hint rather that its color is yellowish, more like the inner planets. Such indications as we have of the object suggest low albedo and high density. Thus far our knowledge

of it is based largely upon its observed path and its determined rates of motion. These with its position and distance appear to fit only those of an object beyond Neptune, and one apparently fulfilling Lowell's theoretical findings.

While it is thus too early to say much about this remarkable object and much caution and concern are felt—because of the necessary interpretations involved—in announcing its discovery before its status is fully demonstrated; yet it has appeared a clear duty to science to make its existence known in time to permit other astronomers to observe it while in favorable position before it falls too low in the evening sky for effective observation.

V. M. SLIPHER.

Lowell Observatory Observation Circular,
Flagstaff, Arizona, March 13, 1930.

Additional information received through the Harvard College Observatory is given here.

TRANS-NEPTUNIAN PLANET.—On a plate of eighty-three minutes exposure made on March 19 with the 16-inch Metcalf refractor at Harvard, the photographic magnitude of the Trans-Neptunian planet is estimated as 16.0 on the International magnitude scale, comparison having been made with the Harvard Standard Region C4 at $7^h\,0^m$, $+15°.0$.

From measures on plates taken with the 24-inch reflector at the Yerkes Observatory Professor Van Biesbroeck has deduced the following positions of the planet:

1930 U.T.	R.A. 1930.0	Dec. 1930.0
March 16.05544	$7^h\,15^m\,42^s.55$	$+22°\,7'\,10''.6$
17.07928	7 15 40.92	+22 7 18.0

HARLOW SHAPLEY.

Harvard College Observatory Announcement Card 112, March 20, 1930.

TRANS-NEPTUNIAN PLANET.—A cablegram received today reports the following position of the Lowell Observatory object by Wolf at Heidelberg. The observation was transmitted from Dr. Kobold, of Kiel, through Copenhagen.

1930	R.A.	Dec.	Mag.
March 19.9206	$7^h\,15^m\,39^s.9$	$+22°\,7'\,38''$	15

HARLOW SHAPLEY.

Harvard College Observatory Announcement Card 113, March 21, 1930.

TRANS-NEPTUNIAN PLANET.—Two positions of the planet, observed by Struve at Neubabelsberg, have been received from Copenhagen:

1930	R.A.	Dec.	Mag.
March 21.9333	$7^h\,15^m\,35^s.0$	$+22°\,7'\,47''$	15
22.9457	7 15 34.0	+22 7 54	

HARLOW SHAPLEY.

Harvard College Observatory Announcement Card 115, March 24, 1930.

RALPH HAMILTON CURTISS, ASTROPHYSICIST

By W. CARL RUFUS.

Ralph Hamilton Curtiss, Professor of Astronomy and Director of the Astronomical Observatories of the University of Michigan, passed away on Christmas Day, 1929, at the Detroit Observatory residence in Ann Arbor. Less than a month before the fateful day, he spent a part of his Thanksgiving holiday with colleagues enjoying his favorite game of golf. A few days later illness interrupted his duties at the Observatory, to which he was loyally devoted, and upon his physician's order he crossed the street and entered the University hospital. Pleurisy was reported, but he was able soon to return to his residence at the Observatory. There, although handicapped by serious illness, he continued to direct the work of the Department of Astronomy and of the Observatories committed to his care, until the end came quietly on Christmas afternoon, when his over-burdened heart quite suddenly ceased. He is survived by his widow, Mary Louise Welton Curtiss, to whom he was married in 1920, and a brother, David Raymond Curtiss, Professor of Mathematics, Northwestern University.

Professor Curtiss was born at Derby in southern Connecticut, near New Haven, February 8, 1880, of Puritan parents, Hamilton Burton and Emily Wheeler Curtiss. His ancestors came to America during the early Puritan migrations and count among their number Colonial Governor Wells of Connecticut, 1654-1658. His parents were loyal Puritans, cherishing the traditions of their stock, deeply religious, and devoted to a stern moral code. His early training instilled into his moral fiber some of the most outstanding qualities that characterized his life, —a high sense of duty and justice and the moral necessity of making life count. His extraordinary devotion to his work, even during his last illness, was born and bred in his blood.

In 1892, partly on account of his father's health, the family moved to California and settled in the town of Redlands. He followed his older brothers, Walter Judson and David Raymond, through the local high school, graduating at sixteen years of age with an excellent record. The three sons responded loyally in the West to the old New England reverence for learning and were inspired with a desire for higher education. They were also trained in the school of experience, as it was necessary for them to earn a part of their college expenses to supplement the total available family assets, which were entirely consecrated and practically all devoted to their higher education. So we find our youthful high school graduate working and saving for a year before entering the University of California. But this was a year of misfortune. His older brother, then a college sophomore, died and the subject of our sketch barely survived a serious attack of typhoid fever. The combined effect

contributed to a heart weakness which persistently recurred for some time.

During his undergraduate days at the University of California R. H. Curtiss not only maintained a high scholastic record, but also took an active part in the social life of the students. He was a member of the Delta Tau Delta fraternity and the College Glee Club. He possessed rare musical ability, played the violin, which was his favorite instrument, and could readily draw a tune out of almost any kind of instrument. Genial and versatile, he became popular both with students and with faculty members. Due to mechanical ingenuity and the influence of Professor E. P. Lewis, he became especially interested in physics. Under Professor A. O. Leuschner, however, he was attracted to astronomy and about the beginning of his junior year he decided to become an astronomer. His excellent academic record was rewarded the same year by election to Phi Beta Kappa and his special ability in astronomy was recognized by appointment the following year as Assistant at the Students' Observatory of the University of California.

On February 15, 1901, he was appointed Assistant at the Lick Observatory. With requirements for the degree of Bachelor of Science practically completed at the middle of his senior year, he was able to join the Lick Observatory expedition to Padang, Sumatra, to observe the total solar eclipse of May 17-18, 1901, where he assisted throughout in the work of preparing the station and in the observations. After his return from Sumatra the young astronomer, who had received the degree of Bachelor of Science, was awarded a fellowship at Lick Observatory, where he was assigned the usual probationary type of routine work. He recorded observations for W. J. Hussey and R. G. Aitken, who were rapidly adding to the number of double stars by their "hair-splitting" observations with the 36-inch refractor. It was here that the life-long association with Professor Hussey began. He helped to reduce observations of Eros made the previous year, read the microscopes on the meridian circle for R. H. Tucker, and assisted C. D. Perrine at the Crossley reflector. Following the activities of the previous year it was rather difficult to adjust himself to the routine of observatory life. He found much relaxation, however, in his musical proclivities, which he shared with J. Stebbins and J. D. Maddrill. After work was over this trio often made old Assembly Room vibrate and resound to the music of violin and guitar with variations on "a fearful and wonderful collection of out-of-the-way instruments" brought up from San Jose. One morning about an hour before dawn a colleague passing the big dome heard him practicing vocal exercises as he was guiding on a comet.

Alternating between semesters at Lick and at Berkeley, according to the usual practice, R. H. Curtiss had an opportunity at the University to elect courses in engineering in addition to his orbital work under Professor Leuschner. On account of exceptional mechanical and instrumental skill he was strongly attracted to the field of engineering. His elections included an undergraduate course in drawing, which he

later used to good advantage in designing instruments. During a period of uncertainty regarding his future career, the influence of Professor Leuschner was invaluable in determining the orbit of his life. At Lick he owed much to Director W. W. Campbell, W. H. Wright, H. D. Curtis, J. H. Moore, and other members of the staff. Possessed with a keen and active mind, untiring devotion to duty, and exceptional skill in the use of instruments, his outstanding ability was soon recognized by his associates, including fellows and older astronomers.

During his fellowship period, 1901 to 1904, he assisted in preparing several joint papers on comets and began independent contributions, the first of which "Photographic Observations of Minor Planets" (*L.O.B.*, **2**, 105-106, 1902) was published in his second year, and contains the positions of asteroids 439 and 415 from photographs made with the Crossley reflector. His culminating research of this period was "I. Proposed Method for the Measurement and Reduction of Spectrograms for the Determination of the Radial Velocities of Celestial Objects. II. Application to a Study of the Variable Star W Sagittarii." (*L.O.B.*, **3**, 19-40, 1904.) This work was presented December 16, 1904, as a dissertation for the degree of Doctor of Philosophy. He summarized the contribution regarding the method of reducing spectrograms as follows:

"Though observational sources of error in velocity determinations from spectrograms are well under control, there still remain small discrepancies in the results obtained by different observers. These discrepancies are directly traceable to sources of error in the reduction and measurement of spectrograms. For the elimination of these errors, it is essential that the conditions which obtain in the production, measurement, and reduction of a spectrographic plate from which the fundamental data for velocity determinations are secured, be exactly duplicated in the production, measurement, and reduction of the stellar spectrograms. This parallelism of conditions may be secured by the employment of the sun as a standard velocity source. The stellar and the solar spectra are then compared by means of some constant terrestrial source of light; for example, an iron spark." (Syllabus on final examination, December 16, 1904.)

The excellence of the method was readily recognized and the adoption of its fundamental principles followed in the chief institutions engaged in radial velocity determination.

The application of the method in the second part of the thesis led to important results not limited to the case of W Sagittarii, but in its broader application to the complex problem of Cepheid variable stars. The theory of the rotation of a single body of non-uniform surface luminosity was rendered improbable in the cases of the type star Delta Cephei and another Cepheid, Eta Aquilae, by the discovery of their variable velocity by Belopolsky in 1894 and 1895 respectively, which placed them in the rapidly growing class of spectroscopic binaries. Likewise, the eclipse theory was untenable on account of the lack of essential correlation between the light phases and motion across the line of

sight. Roberts' heat excitation or heat transfer theory, Klinkerfues' tidal theory advocated by Eddie, Schwartzschild's combination tidal-thermal theory, and Campbell's superposed rotational effects to account for systematic deviation from elliptic motion, had left the problem only partly solved. Based on observations of W Sagittarii with the single-prism spectrograph on the 36-inch refracting telescope, Dr. Curtiss reached the conclusion that the star is a system involving at least two discrete masses, while the secondary features led to a consideration of several alternatives:

"(a) Either the brighter component rotates once in 3.8 days, and not all parts of its surface are equally bright;
(b) Or there are more than two discrete masses in the system;
(c) Or the masses are not spherical bodies of uniform density;
(d) Or strong tides are active in the system."

The thoroughness of the analysis and careful weighing of the proposed alternatives indicated a well developed scientific attitude of mind at this early stage of development. In defense of the thesis he seems to have favored a tidal theory according to the following:

"The most satisfactory explanation of the light variation of this star is found in the action of the tides which would obtain in a system determined from velocity conditions observed in this star." (Syllabus.)

He invented and adopted another explanation, however, the resisting medium theory, that was accepted by many and with slight modifications has been advocated by Loud, Sutton, Brunt, Perrine and others.

After completing the requirements for the degree of Doctor of Philosophy he was appointed Carnegie assistant at the Lick Observatory. Articles on the radial velocities of S Sagittae and Y Sagittarii and on the spectrum of R Scuti and W Cygni were published about this time. An important note was added on W Sagittarii. In addition to the general resemblance between the light and radial velocity variation of Cepheids observed by Belopolsky, Dr. Curtiss noted that the resemblance extended even to the secondary fluctuations in the case of W Sagittarii, although they are not closely synchronous. (*L.O.B.*, **3**, 167-168, 1905.) Although favoring the resisting medium theory Professor Curtiss, with true scientific spirit, ever kept an open mind on the Cepheid problem. This is clearly evident in his later work on the same star, "Velocity Curves from Groups of Lines of Different Chromospheric Heights in the Atmosphere of W Sagittarii" (*Pub. A.S.P.*, **38**, 148, 1926) in which pulsation was tentatively adopted and atmospheric effects were considered.

In 1905, Dr. Curtiss was appointed assistant astronomer at Allegheny Observatory, where he remained two years. There was no spectrographic equipment when he arrived. He coöperated with Director Schlesinger in designing the Mellon spectrograph, which was constructed by the John A. Brashear Company. His experience at the Lick Observatory with the second spectrograph, which succeeded the old Mill's

spectrograph in 1902 and embodied improvements by Campbell and Wright, enabled him to offer valuable suggestions and to incorporate them in the new instrument.

Dr. Curtiss also assisted in inaugurating the spectrographic observational program and was joint author with Director Schlesinger of a paper on "The Orbit of Algol from Observations made in 1906 and 1907." In a later paper "On the Orbital Elements of Algol" (*Ap.J.*, **28**, 150, 1908), Dr. Curtiss assembled available observations on this system and proved the existence of a third body. Minor irregularities suggested another problem solved several years later by one of Professor Curtiss' students at Michigan, Dr. D. B. McLaughlin, who found a radial velocity effect due to the rotation of the bright component. Dr. Curtiss' observations on Beta Lyrae in 1907 and first set of measures made at Allegheny accompanied him to Michigan where his important paper on "The Spectrum of Beta Lyrae" was written and sent back to Allegheny for publication. (*Pub. Allegheny Ob.*, **2**, 73-120, 1911.)

The same year that Dr. Curtiss joined the Allegheny Observatory staff, Professor W. J. Hussey was also called away from the Lick Observatory. In 1905 Professor Hussey was elected director of the Observatory of the University of Michigan and immediately began a comprehensive development program. In 1907, the construction of a large reflecting telescope was undertaken and plans were made to provide a stellar spectrograph and accessories for modern astrophysical research. At this time he secured the services of Dr. Curtiss as Assistant Professor of Astronomy to help in the inauguration of the work in astrophysics. Professor Curtiss immediately began the design of the single-prism spectrograph for the large reflector. He adopted the same general type as the Mellon spectrograph with modifications suggested by experience at Allegheny. A complete set of drawings was made for the spectrograph including optical parts, slit-head, comparison apparatus, plate holders, thermostat and thermometers. The order was placed with the John A. Brashear Company, makers of the former instrument. Upon the arrival of the spectrograph an investigation of the optical parts and mechanical construction was followed by completing the designs for the supporting truss, guiding telescope, and temperature case, all of which were constructed in the Instrument Shop of the Observatory. Upon the completion of the 37½-inch reflecting telescope, the spectrograph was attached and on May 25, 1911, the first test exposures were made on Alpha Boötis and Beta Lyrae. Since that time about 10,000 spectrograms have been made with this equipment, the quality of which attests the excellence of the design and the construction.

His descriptive paper, The Single-Prism Spectrograph of the Detroit Observatory, may be found in Volume I of the *Publications*. His other contributions to this volume include Miscellaneous Observatory Notes, with W. J. Hussey, The Geographical Position of the Observatory of the University of Michigan, A Determination of the Visual Light Curve of Beta Lyrae, Some Possible Characteristics of Cepheid Variable

PLATE V

RALPH HAMILTON CURTISS
1880-1929

Stars, and Studies of the Spectra of Delta and Epsilon Orionis.

As a major program for the new spectrograph Professor Curtiss selected Class B stars having emission lines in their spectra in continuation of his work on Beta Lyrae begun at Allegheny. His papers on stars of this class constitute an important part of Volumes II and III of the *Publications of the Observatory* and include studies of Gamma Cassiopeia, f^1 Cygni, H.R. 985, also an investigation of the widths of hydrogen and metallic emission lines in Class B stellar spectra and a statistical study of data bearing upon the nature of this class of stars and upon their relation to stellar evolution. Notes on the method of determining elements of spectroscopic binaries and on the reproduction of spectra in Volume II were also added. The apparatus for enlarging and widening spectra and the excellence of the results obtained at Michigan are due to the design and method perfected by Professor Curtiss. His Pictorial Study of Nova Geminorum II, including the frontispiece of Volume III, is perhaps the best illustration of the beauty and value of these enlargements.

His bibliography also contains about 25 articles in astronomical journals and popular magazines. A paper on Vibrations in the Vicinity of Drop Forge Hammers, (*American Drop Forger*, **1**, 83, 1915) followed experimental work for scientific testimony in a damage suit. Two unpublished papers of a similar nature illustrate his interest in earth vibrations. A careful observer at all times, he thoroughly investigated whatever came to hand.

In 1911 Dr. Curtiss was made Associate Professor of Astronomy and Assistant Director of the Observatory of the University of Michigan. From 1911 to 1917 he was frequently left in charge of the Astronomical work at Michigan on account of Professor Hussey's additional appointment as director of the Observatorio Nacional de La Plata, which necessitated a division of time between Michigan and South America. In 1918 he was promoted to a professorship. Following the tragic death of Professor Hussey on October 28, 1926, he was appointed Director of the Observatory of the University of Michigan and placed in charge of the Lamont Astronomical Expedition to South Africa.

Since his arrival at Michigan Professor Curtiss also taught many of the graduate courses in spectroscopy and astrophysics. His lecture notes are clear, accurate, and concise. He took a personal interest in his students' welfare and won many of them as lifelong friends. Contributions by his students, especially theses for the doctorate, maintain a high standard of research. Three were published in Volume II of the *Observatory Publications* and several remain for future volumes. The following list of theses subjects investigated under his direction indicate the wide range of interest.

1. A Study of the Spectrum of ζ_1 Ursae Majoris, Laurence Hadley, 1915.
2. An Investigation of the Spectra of Stars belonging to Class R of the Draper Classification, W. Carl Rufus, 1915.

3. A Study of Beta Cephei, Clifford C. Crump, 1915.
4. A Study of the Orbit of the Brighter Component of Beta Lyrae, Richard A. Rossiter, 1923.
5. A Study of S Sagittae, John A. Aldrich, 1923.
6. A Study of the Relative Proper Motions and Radial Velocities of Stars in the Pleiades Group, Agnes E. Wells, 1924.
7. The Spectrum of Zeta Tauri, Hazel M. Losh, 1924.
8. Spectrographic Studies of Eclipsing Binaries, Dean B. McLaughlin, 1927.
9. A Study of the Spectrographic Observations of Phi Persei, Oscar Lee Dustheimer, 1927.
10. A Spectrophotometric and Spectroscopic Study of Phi Persei, Herbert F. Schiefer, 1928.
11. A Micro-photometric Study of Beta Lyrae, Laura Hill McLaughlin, 1929.
12. A Study of the Spectrum and Orbit of Upsilon Sagittarii, Frances Louise Seydel, 1929.
13. A Study of the Variation in Wave-length of Individual Lines with Spectral Class from F to K, Marian Alberta Hawes, 1929.
14. A Spectrographic Study of P Cygni, Walter J. Williams. Begun under Professor Curtiss, but not yet completed.

In the work of his students as well as his own research he emphasized accuracy, thoroughness, careful attention to details, a maximum of observational data, and a minimum of hazardous conclusions. His working ideal seemed to be: "Trifles make perfection, but perfection is no trifle." The supervision of the work of thirteen successful candidates for the degree of Doctor of Philosophy is in itself a great achievement. All have gratefully acknowledged their indebtedness to Professor Curtiss in their dissertations, but a formal statement of that nature is very inadequate to express their depth of feeling. One has recently written: "For years Professor Curtiss has been one of my best friends. When I was working for my degree, he was always patient, always kind, always helpful. Since I left the University I have turned to him again and again for counsel and for guidance. He never failed me."

Astronomers at other institutions frequently consulted him by correspondence or by personal conference for his expert advice which was always given unstintingly. Grateful acknowledgments were received from many. Dr. J. S. Plaskett, Director of the Dominion Astrophysical Observatory, in his "Description of Building and Equipment," (*Pub. D.A.O.*, **1**, 10, 1922) gives the following tribute: "At the Detroit Observatory, Ann Arbor, where is a 37½-inch reflector of quite recent construction, I also obtained useful assistance in many details of construction, and am indebted to Dr. Curtiss for his willingness to assist in every possible way." Correspondence with astronomers regarding the construction of spectrographs, the making and enlarging of spectrograms, developing plates, and other matters was very extensive. Letters

from rather trivial inquirers, including "paradoxers" were courteously and painstakingly answered.

The teaching of courses in Descriptive Astronomy has been emphasized at Michigan for many years and Professor Curtiss ably upheld the high standard of his predecessors. His lectures were clear and concise, always presented in excellent style, with careful attention to details and faultless choice of scientific terms. Many letters from former students indicate that a lasting interest in astronomy was inspired. One of the most significant was written two days after the outburst of luminosity of Nova Aquilae, No. 3, 1918, by a soldier at Fort Du Pont, who had independently discovered the nova one evening when he was on guard duty. Four years of military training at the University of California and a commission as Captain of University Cadets gave Professor Curtiss a sympathetic relationship to the boys in khaki. His teaching of navigation at the time of the World War was a real service for his country. One summer on the Great Lakes was spent in practical seamanship to assist in preparation for this work. Hundreds attended his courses in Navigation given at the University and a letter from Rear Admiral Berry gave formal thanks for this valuable service. One of his former students gives this interesting characterization:

"During the war Dr. Curtiss trained many embryo sailors in the beautiful and accurate science of navigation, taught them to 'shoot Polaris' and use the *Ephemeris* and fill in the Bowditch formula,—made them 'Sextant sailors' instead of mere coastwise and 'day's work' sailors. Yet there was nothing which gave him greater pleasure than a summer great lakes cruise when he could sit down and swap yarns with a skipper taking his bearings from a 'star' which was only a lighthouse beam. He had the fine humor, great nature and kindliness of the man who lives at sea and with limitless spaces; and with it a poet's soul and the brain of a remarkable scientist and mathematician."

At the close of the war Professor Curtiss expressed this sentiment: "Navigation has been very absorbing and compelling. It has given me some of the most interesting experiences I have ever had. I hope that I may teach it to some extent as long as my teaching days last." This hope was realized.

Well deserved recognition came to Professor Curtiss from numerous national and international scientific organizations. He was a member of the American Astronomical Society and of its Council, member of the American Association for the Advancement of Science, fellow of the Royal Astronomical Society, member of the Seismological Society of America, International Astronomical Union, American Association of University Professors, Research Club of the University of Michigan and of the honorary societies Gamma Alpha, Sigma Xi, and Phi Beta Kappa. He was serving as president of the Michigan chapter of Phi Beta Kappa this year. He was a member of the important Commission No. 29, Classification Spectrale, of the International Astronomical Union. An invitation to contribute a section on the Classifica-

tion and Description of Stellar Spectra for volume four of the "Handbuch der Astrophysik" was accepted by him as one of the highest honors of his professional career. Fortunately the text of his part of the work was practically complete at the time of his death.

Stricken down in the midst of many projects in various degrees of progress he left much unfinished work. The research subjects in which he was engaged include:

1. Spectrographic Studies of Class Be Stars, in continuation of his published work, including f^1 Cygni, H.R. 985, Beta Piscium, 11 Camelopardalis, and 25 Orionis. To aid in the measurement and reduction of spectrograms of stars of this class, a grant by the National Academy of Sciences was made.
2. Delta Cephei and the Cepheid Problem. An appropriation from the same source was also made for this work, which was being carried on in accordance with a new method of isolating lines at different atmospheric levels first used at the Observatory of the University of Michigan.
3. Novae, including Nova Aquilae, No. 3, 1918.
4. R Scuti, A Spectrographic Study and Study of the Light Variations.
5. The Light Variations of several bright variables including S Sagittae, Delta Cephei, Beta Lyrae, Delta Lyrae, and novae .
6. Stellar Evolution. A new paper was begun, previous ones were given in 1917 and 1924.
7. Photographic Stains. An unpublished paper of work from 1922 to 1925.
8. Description of Two-Prism Spectrograph. This instrument was recently designed by Professor Curtiss and constructed in the Observatory Shop by Mr. H. J. Colliau.

The research members of the Observatory staff are planning to take over unfinished research problems for completion and publication in a memorial volume in order that the work of Professor Curtiss may be conserved in the interest of the science he loved and the institution he served faithfully unto death.

The Student Observatory and Astronomical Laboratory on the fifth floor of Angell Hall, erected during the closing days of Professor Hussey's administration, were equipped under the direction of Professor Curtiss. A 10-inch refracting telescope and a 3-inch transit instrument were installed and additional laboratory equipment was provided. A 15-inch reflecting telescope was also designed and is now nearly ready for assembly. The optical parts were ordered, tested, and approved by Professor Curtiss. A Hale spectrohelioscope was purchased last year, on which tests and adjustments were in progress just prior to his illness. A Moll recording microphotometer recently arrived, which Professor Curtiss had ordered and planned to use in spectrophotometric work to carry on in connection with his spectrographic researches.

Due to the continued liberal support of Secretary Lamont, the wise direction of Professor Curtiss, and the efficient service of Dr. R. A. Rossiter at Bloemfontein, the 27-inch Lamont refractor was successfully installed and the double-star program has progressed satisfactorily in spite of the great loss due to the death of Professor Hussey en route to initiate the work. More than 2000 new pairs have been discovered and a large number remeasured. Professor Curtiss' active interest in this work is clearly indicated by his last published article, "On the Separation Limits of Double Stars and the Relative Numbers of Optical and Physical Pairs," in which he advocated extending double star searches to the separation limits of the formula, $\text{Log } \rho'' = 2.5 - 0.2\,\text{m}$. (*J.R.A.S.C.*, Dec., 1929.)

The development of plans for a new observatory was in progress by Professor Curtiss. The present site was rendered unsatisfactory by the gradual encroachment of several large buildings, including the power plant of the University which is to the southwest, the direction of prevailing winds. A new site was selected about fifteen miles northwest of the city, an appropriation was secured, and the land was finally purchased just before the death of Professor Curtiss. Tentative plans for new buildings to house the equipment to be moved and preliminary designs for new instruments, including a larger and more efficient reflecting telescope, had been drafted to incorporate his ideas which will undoubtedly be carried to completion and stand as a monument to his memory.

Professor Curtiss also took an active interest in social affairs. He was a member of the Barton Hills Country Club and the Winans' Lake Country Club, the latter of which was near his summer home. He enjoyed membership in the Kiwanis Club and entered heartily in its activities. He contributed to local social and civic organizations and served on the board of directors of the Young Men's Christian Association. His interest in the Boy Scouts of America led to valuable suggestions regarding the "Handbook for Boys," especially pertaining to work for merit badges in Astronomy. He entered enthusiastically into various sports, was an ardent fisherman, a modest but skillful golfer, and loved to roam the wooded hills.

These characteristics and contacts endeared him to a wide circle of friends in various walks of life who join to mourn his early death. Letters and telegrams of sympathy came to Mrs. Curtiss and to the Observatory from prominent astronomers of America and Europe, from the Secretary of Commerce, the Governor of Michigan, members of the University, scores of former students and hosts of personal friends,—a living tribute to the memory of a brilliant scientist, loyal public servant, devoted director, inspiring teacher, and helpful friend.

Ann Arbor, Michigan, February, 1930.

THE ASTRONOMICAL FRATERNITY OF THE WORLD

By DAVID B. PICKERING.

PART VIII.

The Grand Canal in Venice is referred to as the most romantic highway in the world. Surely then the Rhine may safely be called the most romantic of rivers.

The picturesque history and wierd folk-lore, which are associated with every turn of its broad tide vie in interest with the scenic splendor of its course. It is ever on parade—and always in full dress. There are times, however, when Dame Nature, perhaps to subdue its pride, flings a nebulous veil of moisture over its broad path and it was, unfortunately, on such a day of cloud and shower that we made our first excursion down this famous waterway.

There are few adventures for which the casual traveler entertains more pleasant anticipations than that of his first Rhine voyage. During the railway trip from Heidelberg to Mainz we discussed its vineyards, its castles, and its storied isles. At Mainz we were thrilled with our first view of its broad flood and there through the night we dreamed of Fafner and Mimi—of the Rhine maidens and the Lorelei.

Bonn, that fine old University city which nestles on the bank of the river ninety miles farther on, was our objective; and next morning we boarded the graceful white steamer and sailed away with the tide. To many of the Germans about the long table in the dining salon, who had become satiated with the familiar beauty of the scenery, it was just another day of beer and cheese and sausage, but we clung to our points of vantage on the after deck and with whetted imaginations thrilled as each famous prospect passed before us. There on our left was Bingen with its famous mouse tower and opposite, the vine-clad hills rise to the foot of that heroic Neiderwald monument of Germania, erected at the conclusion of the war of 1870. Castle after medieval castle on each of a hundred eminences. There on its little island stood the thousand-year-old fortress of the Pfalz, and soon we rounded that precipitous, bare headland where, in the misty past, so legends tell, the siren lured sailors to their doom—the Lorelei. Then came Coblentz with its great equestrian statue of Emperor William the First, and the old pontoon bridge which crosses the river at this place. On the opposite height loomed the fortress of Ehrenbreitstein, so intimately associated with the A.E.F. Later in the day we saw the lace-like spires of the Apollinaris church on the hills at the left, and still later passed that beautiful group of mountainous elevations on the right bank, known as the Siebengebirge, on one of which stands the ancient ruin of the castle of Drachen-

fels. It was sunset when we disembarked at Bonn. Thereafter, feudal castles were to have a more vivid significance, German folk-lore a deeper meaning, and Rhenish wine a more delicate flavor than ever before.

It was not surprising to find the University of Bonn housed in the city's finest building. This was erected in 1818 by King Friedrich Wilhelm III of Prussia and is built on the foundation of the old Electoral Palace which dates from 1717.

It was Sunday, the 22nd of May, 1927, on a day of sunshine and showers, that we strolled along the edge of a beautiful park, spread out before the long, low southern wing of the University, on our way to the University Observatory.

The town was in gala attire—from every window fluttered German flags—excited crowds were gathering in the streets, and for very good reason. On an obscure little side-street of Bonn, in the year 1770, the wife of a tenor-singer at the court of the Archbishop-Elector gave birth to a son. Long afterward Bonn was to take vast pride in being the city of his nativity. No wonder the excitement ran high, for today they were to commemorate the one hundredth anniversary of his death. A feast of love to honor the memory of Ludwig van Beethoven.

As we approached the square we saw the people from the side streets flocking toward the Münster—that ancient, gray-stone, Romaneque church which, with its five impressive towers, forms one of the landmarks of the Rhine valley—wherein the ceremonies were to begin. Others made pilgrimages to the obscure little house in which Bonn's favorite son had first seen the light. But we continued on; eschewing this shrine of art and the gathering crowds, for another shrine—a shrine of science, where no crowds gathered.

Beyond the Square we proceeded to the broad avenue of Peppelsdorf which, with its central grass-plat, borders of chestnuts and rows of fine residences, extends for a mile westward from the heart of the town. On the south side of this avenue, midway of its length, one enters a wide gateway; between tall hedge-rows a winding path, bordered by a great variety of shrubbery, leads to the garden-like site of the Observatory. The rectangular, two-storied building is surmounted by a circular observing room of the "pill-box" type, having, at equal distances about its circumference eight full length windows with diamond-shaped panes. A wing of one story extends from the western end of the main edifice, having a slit of about two and a half feet in width at sides and top, with removable shutters, to admit of meridian observations. The extremity of this wing has circular corner towers, each nine or ten feet in diameter and each supporting a telescope house. These are identical in character with the central observatory, except that each has ten windows instead of eight. The central observatory, however, is about twice the diameter of either of the others and is slightly more elevated.

It was in 1845 that the building was erected; a period which seems to have marked a new epoch in astronomical history, for it was about

that time that Lord Rosse's great glass found the first spiral nebula; Mertz had just made the two largest refractors in the world, each of fifteen inches aperture, one for Harvard and the other for Pulkova; and Draper and Bond were making initial experiments in celestial photography.

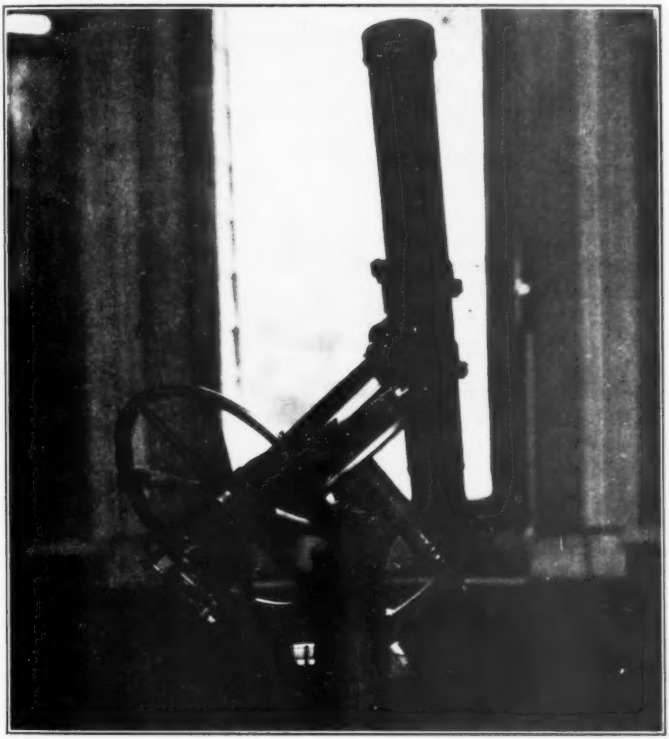
At the side of the main building stands a conventional dome of more recent acquisition, housing a 15-inch refractor.

OBSERVATORY OF THE UNIVERSITY OF BONN, GERMANY.

There was no response to our ring at the main entrance but, finding the door unlocked, we entered and looked about the high-ceiled rooms at right and left of the broad central hallway. There were the expected appurtenances of the library and computing room. It was not long before we were approached by a short, stocky gentleman, who introduced himself as Herr Sesterhenn, an assistant astronomer, who had at that time been with the institution for twenty-four years. All except him had gone to attend the Beethoven celebration. Much to our disappointment he explained that Professor Kohlshutter, the Director, had recently left for America, but very affably expressed his willingness to show us about. What a busy man this Mertz must have been, at the middle of the 19th century; here was a 6-inch heliometer of his, one of the observatory's early instruments. In the wing were, of course, the meridian circles.

It was only after we had been shown all else that Herr Sesterhenn conducted us to the foot of the narrow stairs that led to one of the little observatories, atop its tower, in the west wing. Silently we tip-toed up the steps, in a spirit of reverential awe, for we knew that we were ap-

proaching a veritable shrine—unique in astronomical history. At the top of the stairs we found ourselves in a small circular enclosure, and by the subdued light that filtered through the curtained windows, discovered on its central pier, a modest little short-focus telescope, of about three inches aperture and all out of proportion to the great circles which its mounting bore. These may have been fifteen inches in diameter; the declination circle being fully as wide as that axis of the mounting.



THREE-INCH TELESCOPE, USED BY ARGELANDER IN MAKING THE "DURCHMUSTERUNG."

For a long moment we preserved a respectful silence. It did not strain the imagination to conjure up the ghost of that genius who, seventy-five years before, had, with the aid of his faithful assistants, accomplished so much with this poor little Fraunhofer comet-seeker. Herr Sesterhenn leaned over and touched a simple wire that followed the curve of the stair-well. Far away a bell jingled. That had been used to call an assistant, when the tired body rebelled after hours of exertion;

an assistant who would carry on as long as the stars could be seen.

There in our mind's eye he stood—Friedrich Wilhelm August Argelander—Director of the Observatory of Bonn from 1837 until his death in 1875. We saw him as he was during the period from 1852 to 1859, engaged in the work that was to crown the splendid efforts of his busy and successful life. We could imagine him well past middle age, bushy hair aside the temples, wide straight mouth and piercing, deepset eyes, bending over the telescope in the starlight. Just below the observing room an assistant sits before a sidereal clock and records the time of the signals that are tapped upon the floor as each star crosses the vertical line bisecting the ocular, and records the magnitude that the observer calls. The latter himself enters the declination upon cards arranged for the purpose at his side. The strain of the exacting work at last calls a halt; the assistant is signalled, and straightening his tired back the old Director reaches for the wire at the stair head. In response to the distant jingle, up there hurries a young man who, though still in his twenties, is Argelander's faithful assistant and co-worker in the great undertaking at hand. This young man is Eduard Schönfeld, who had recently determined to abandon the practice of architecture, for which he was trained, and make the study of his beloved stars his vocation. Another assistant is Adalbert Krueger, who married the daughter of the Director, and in time became himself Director of the Observatory of Helsingfors and later of that at Kiel. Below stairs the observed positions are carefully entered upon cards, each about five by eight inches in size, and filed away. On nights when moon or clouds make observing impossible, the observers check their past results or struggle with the problem of the light changes in the variable stars.

The task which Argelander and his assistants had undertaken in 1852 was the observation by zones, of all the stars in the sky which his glass would show, from the pole to —2 degrees of declination, and the plotting of their positions in a great catalogue with accompanying maps. In 1859, after seven years of patient effort, the great task was done and the "Bonner Durchmusterung" was ready to prepare for publication. Within a few years both Catalogue and Atlases were available to the public. Though its faintest stars are limited necessarily to those of between the 9th and 10th magnitudes, the maps show the positions of 324,198 stars.

Argelander is accepted by many as the "Father" of variable star observation. No student of those fascinating objects should fail to read his plea for the observation of Variables. Many observers throughout the world have responded to its urge. It was published in Schumacher's "Astronomisches Jahrbuch" of 1844, at which time Argelander records only 18 known variable stars. POPULAR ASTRONOMY for February, March, and April, 1912, published a splendid translation of this German article, by Dr. Annie J. Cannon, which has, in part, been republished in "A Source Book in Astronomy" by Shapley and Howarth. I cannot refrain from quoting Argelander's climactic appeal contained therein:

"Therefore do I lay these hitherto sorely neglected variables most pressingly on the heart of all lovers of the starry heavens. May you become so grateful for the pleasure which has so often rewarded your looking upward, which has constantly been offered you anew, that you will contribute your little mite towards the most exact knowledge of these stars! May you increase your enjoyment by combining the useful and the pleasant, while you perform an important part towards the increase of human knowledge, and help to investigate the eternal laws which announce in endless distance the almighty power and wisdom of the Creator!" Again he says: "Could we be aided in this matter by the coöperation of a goodly number of amateurs, we would perhaps in a few years be able to discover laws in these apparent irregularities, and then in a short time accomplish more than in all the years which have passed since their discovery." A charge which has since inspired hundreds of amateur astronomers to devote themselves to this fascinating and select branch of astronomy.

Shortly after the completion of the "Durchmusterung," Schönfeld left Bonn to become Director of the observatory at Mannheim. Long, long afterward he returned to end his days at Bonn, where he succeeded his old master as Director of the Observatory, after the latter had gone to his long rest. It was here, in 1875, nearly a quarter of a century since work was begun on the first great atlas, that Schönfeld undertook the task that was to crown his career and complete that which he had helped to start. This lay in extending the *Catalogue* and *Atlas* to include stars down to —23 degrees. With the aid of a larger glass and the advantages of time and experience this was accomplished in 1881 and included 363,932 stars of which 133,659 were published in a Catalogue as Vol. VIII of the "Durchmusterung." Lying by my side as I write are D. M. Maps from which photographs will soon be made, three times enlarged, of the fields of variable stars. These will be traced and blue-printed to supply more of the familiar "b" type charts to the members of the A.A.V.S.O.

After descending the narrow stairway we stopped to examine the cards upon which the records were kept. They were neatly filed in pasteboard boxes—mute relics of a great achievement.

Leaving the building we came out upon an open garden back of the towered wing, where a year later we were to be entertained, on one glorious moonlit night, by Professor Kohlshütter and his charming wife. This was at the time when the members of the I.A.U. were journeying from Leiden to Heidelberg to attend the regular meeting of the Astronomische Gesellschaft. The Editor of POPULAR ASTRONOMY has told you of this delightful occasion, where the guests sat beneath the lantern-hung trees and, amid the good-fellowship of their friends, indulged in delicious refreshment while listening to the wonderful German music which an orchestra of strings poured forth from the shadow of the foliage. All out under the stars.

In Bonn is the tomb of Robert Schumann, whose melodies express

the softest sentiment of all German music. As we later stood in Cologne and gazed at that vast and towering cathedral whose massive base seems to have grown out of the very earth beneath it, we recalled vividly a strain from one loved song of Schumann's: ". . . mit seinem grossen Dome, das grosse heilige Coln."

We continued to Amsterdam—the little Venice of Holland—and one day ran out to the interesting and historic town of Utrecht, as famous for its University as for its velvets. What a time we had at the railway station finding anyone who could understand either English, or the poor broken German that had sufficed so often before. We succeeded at last, however, and after traversing several streets and canals came upon as restful a scene as we had encountered for a long while. Here was a curving waterway, crossed by a slender bridge, at

Main Building of Observatory of the University of Utrecht.

the sides of which the trees stretched leafy limbs far out over the still water. Both banks were thick with shrubbery, back of which wide pathways curved. Reaching a bend in the stream we saw through the boughs of the trees the domes that marked our destination. Here at the Observatory of the University of Utrecht we had hoped to meet those well-known and genial gentlemen whose contributions to variable star astronomy and other branches of the science had made their names familiar everywhere: Professor Nijland, the Director, and Dr. Van der Bilt. We were, however, doomed to disappointment. As we reached the portal we intercepted a gentleman who was leaving hurriedly to keep an engagement elsewhere. He informed us that Professor

Nijland was away upon a vacation and that Dr. Van der Bilt had recently left upon his honeymoon. Furthermore, he himself could not delay his departure and there was none other at the time to show us about the institution. So, as someone has said, "That was that." We were forced to be content with gazing upon the attractive home of Science from the outside, taking pictures of the domes where are housed the 10-inch Steinheil refractor and other instruments unknown to us. We crossed a bridge and from the opposite side of the stream caught our last glimpse of the two round domes through the trees that lined the bank. Again it was the great meeting of the I.A.U. in 1928 that gave us the chance to meet those splendid men of Utrecht. Furthermore it afforded us the pleasure of becoming acquainted with Mrs. Van der Bilt, because of whom the good Doctor was absent at the time of our visit. I became associated with Professor Nijland in the Variable Star Commission and was not surprised to find in this plump little man with the round face and diminutive goatee, the energetic man of affairs that his reputation proclaimed him to be. He happened to be the last member with whom I came in contact after the conference had closed. Members and delegates were hurrying to leave the city and Professor Nijland and I stepped into the well-known restaurant where the members of the Union usually gathered at midday.

We had tongue sandwiches with our beer and hurriedly discussed some final matters relating to the work of the Commission, while we as hurriedly ate. Becoming aware that only by further hurry could he make his train for Utrecht, the rosy-faced Professor bade me a hurried adieu and fled for the door, still grasping the remnant of his tongue sandwich.

How noisy and excited seemed the flag-bedecked Leiden of July, 1928, as it entertained astronomers from all about the world, compared to the quiet soberness of the town at the time of our first visit the year before. At that earlier period, we had one day taken a train from The Hague and ridden out through attractive suburbs and across great flat meadowlands cut into regular rectangular plots by straight water ditches.

From the edge of the town of Leiden we found our way, with the aid of a street map, to the vicinity of the University Observatory. Having seen reflected in the dark waters of a broad canal the domes of what was obviously the scene of our quest, we inquired, in our best German, of a lethargic-looking person seated by a high iron gateway, the route to the observatory. Prompted by malice, ignorance, indifference, his aversion to foreigners, or the fact that he may have had a poor lunch, this individual directed us to the bridge at our left, from which we had first obtained such an enchanting view of the observatory. From here it had appeared to be not over a quarter of a mile away. Across the bridge we followed a foot-path that skirted the water's edge. It was a charming walk, but the day was hot and burdened unwisely with overcoats, we were not especially desirous of a promenade after our long

walk from the station. The canal bent in a great curve as we wended our way. Through the trees we could catch occasional glimpses of the institution that we were trying to reach, but strangely enough, it never seemed to draw a bit nearer. We became hotter and more exhausted every minute. Several passersby whom we tried to question failed to understand our appeal. We must have labored on for nearly a mile when finally, as we were in utter despair, a Good Samaritan turned us

Observatory of the University of Leiden.

about face, and told us to go back to where we had come from. The iron gateway we had left, was the entrance to the observatory grounds. The sky was blue above us—but even bluer now became the air about us, filled with my unprintable remarks. We pushed through the heat for an eon or two and at last, almost ready to drop, found ourselves again before that portal. Much to my disappointment the lethargic individual had gone. All the way back I had speculated on the most painful manner of effecting his demise. Had he not left, I might even now be breaking stone in some unpleasant place.

Once inside the gate, a broad path led by several dwellings and what we later learned were laboratories. Beyond and at our left hand, the main building stood upon somewhat higher ground.

Professor Hertzsprung, dean of specialists in variable star research and famous member of the staff at the Leiden Observatory, had been our guest of honor at the last fall meeting of the A.A.V.S.O., but believing that he had not yet returned to Leiden, we came armed with a letter to Dr. Oort. It was for this gentleman then that we inquired from a bright young man whom we encountered near the entrance to the main edifice.

He made it clear to us that Dr. Oort was not there and tried to explain to us the reason for his absence, but we failed to understand him. We inquired if he was ill. The young man choked as he tried politely to suppress his mirth. If we could only have understood him as well as he seemed to understand us. We asked if the Doctor had suffered an accident—more choking and more unintelligible explanations.

We had to let it go at that. We felt that a calamity of some kind had overtaken Dr. Oort and kept him from his post. What its nature was we could not imagine, nor why our inquiries should so amuse our young friend. But we understood later, when we learned that, like Dr. Van der Bilt, Dr. Oort was away upon his wedding trip. It was of this that the youth was trying to inform us, when he so unwittingly aroused our sympathies. It certainly seemed as if there must have been some connection between our pilgrimage to Holland and the activities of the god Hymen.

From our young man we *did* manage to learn that Professor Hertzsprung had returned home only that week, and it was in the aforesaid laboratory that we soon found him. Professor Hertzsprung is a man of very large frame, whose rapid gestures bespeak a highly nervous temperament. The quick movement of his keen eyes, above the full but roughly pointed beard, further suggests an immense store of nervous energy. Despite this evidence of power, no one—not even Professor Eddington—could be more shy. His embarrassment at times is almost painful, particularly when his voice breaks into a chuckle, as it often does, without a sign of a smile appearing on his face.

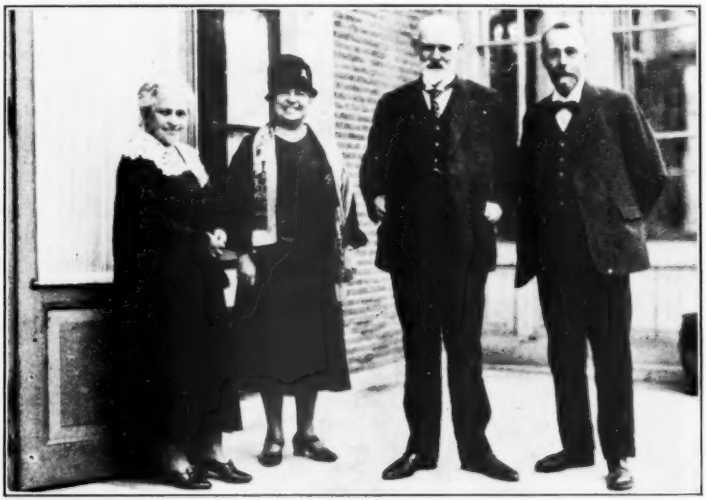
He greeted us most graciously and conducted us about this workshop of his with its many instrument rooms, wherein he and his assistants are little by little wresting the truth from the stellar plates under examination.

Somewhat later he accompanied us up the path to the main building, in one wing of which is the home of the Director, Professor de Sitter.

We were fortunate indeed, on this occasion, to find both the Director and his good wife within and disengaged,—and what a welcome they gave us! Miss Cannon had told us of their charm and friendliness, but the stranger within the gates is never quite prepared for the gift of hospitality which it seems so natural for the generous-hearted to bestow. Here was this tall, slender gentleman with the gray VanDyke beard—he to whose theories of cosmology all the world has given ear—greeting us as if we, of all people, were the ones he had most wished to see and for whom he had been impatiently waiting. Mrs. de Sitter is short,

rather plump and possesses that soft motherliness which one just naturally expects to find in persons of that type.

Of course we were shown about the Observatory, which is one of the oldest in Europe, having been founded in 1632, but in which little was done until the coming of F. Kaiser, as Director, in 1837. The present observatory was begun in 1858 and houses refractors by Repsold and Mertz of 10½ and 7 inches, respectively. More interesting is the large collection of historic things of science displayed about the large, well-lighted rooms of the ground floor. From the side of the building opposite the wide canal, the windows look out upon the Botanical Gardens where, in the following year, so many famous scientists were to gather



Mrs. de Sitter, Mrs. Pickering, Professor de Sitter, Professor Hertzsprung.

in delightful comradeship, while being entertained by a colorful group of young ladies attired in the picturesque costumes of the Dutch provinces. It was to the veranda upon the other side, however, which overlooked the garden sloping down to the water, that we were summoned for tea. Here we told our smiling host and hostess what we could of their friends in America, and were charged, you may be sure, with messages to deliver to them, upon our return.

This was to be the last port of call in our voyage among Europe's domed institutions of science. Great lenses and reflectors, famous and historic instruments—except such as that at Bonn, about which hover the ghosts of the great,—seem not to appear in the mirror of memory with the same vivid reality as do those people who employ them. There come uppermost in our minds, as we now look back over those little excursions, the kindly faces of each one of that Brotherhood and Sister-

hood of star lovers. Is it the ennobling influences of their vocation which prompts the warm greeting, the interested fellowship, the hearty farewells?

We only know that always there seemed time in their busy lives to give us of their comradeship and to extend to us the hospitality of their homes. Yes, the most pleasant memories, and the most lasting, are of those smiling faces. And the last smile of all was that of Mrs. de Sitter, who walked with us down the path to the great iron gate, and bade us God-speed on our way.

PRELIMINARY REPORT ON THE PROBABILITY OF CLEAR SKY FOR THE 1932 TOTAL ECLIPSE OF THE SUN

By FREDERICK SLOCUM.

The eclipse of August 31, 1932, begins at sunrise north of Siberia, passes within about 5° of the north pole, comes down across Hudson Bay, Province of Quebec, northern Vermont, New Hampshire, southwestern Maine, the eastern projection of Massachusetts, and ends at

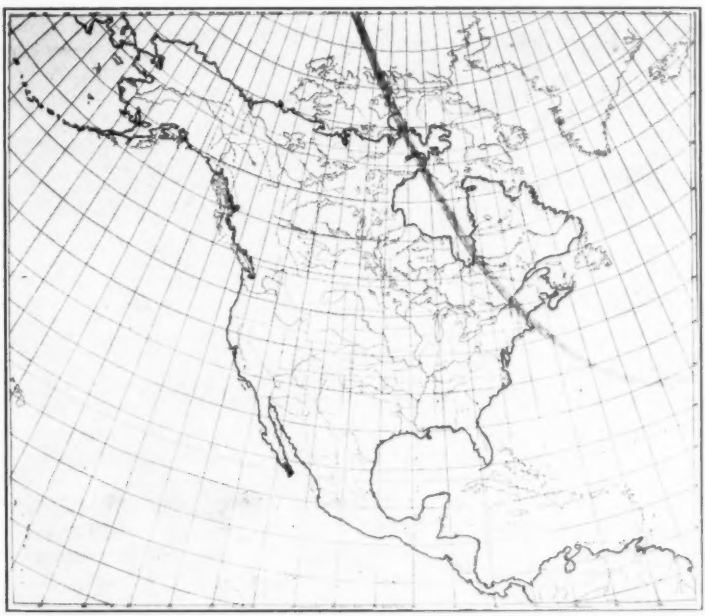


FIGURE 1.
PATH OF THE TOTAL ECLIPSE OF THE SUN, AUGUST 31, 1932.

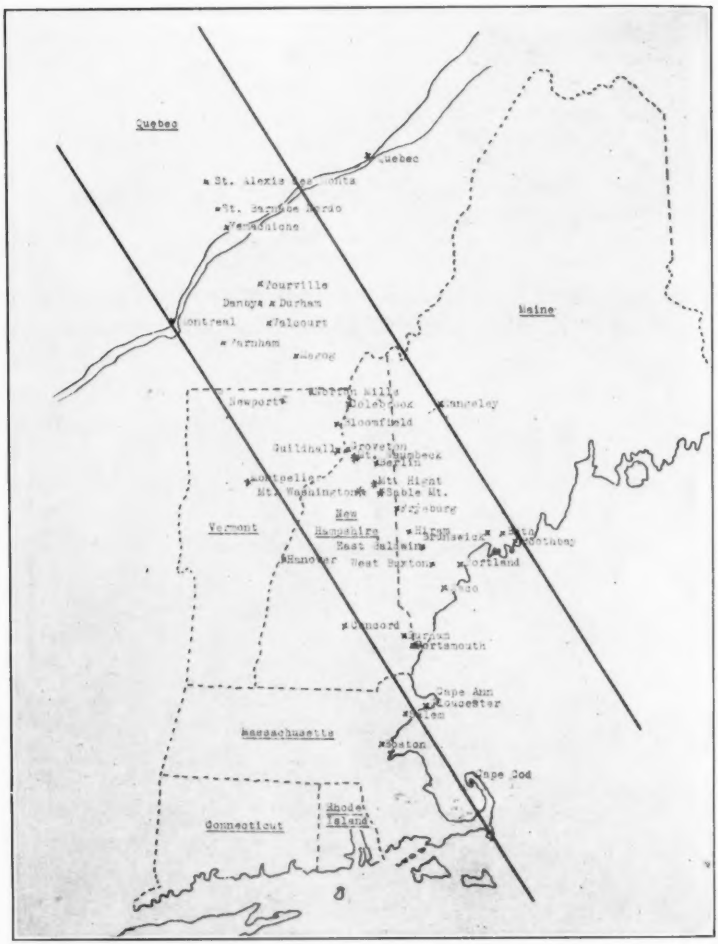


FIGURE 2.
PATH OF THE TOTAL ECLIPSE OF THE SUN, AUGUST 31, 1932.

sunset in the middle of the Atlantic Ocean. Observations will be limited chiefly to the region between Hudson Bay and the Maine coast. Within these limits the duration of totality will vary from 105 seconds at the southern edge of Hudson Bay to 98 seconds on the Maine coast. Within the same limits the local time of totality ranges from $2^h\ 50^m$ to $3^h\ 50^m$ P.M. and the altitude of the sun from 33° to 29°.

Figure 2 shows the path across Quebec and New England and gives

the names of the more important towns near the center line. These are all easily accessible either by rail or auto. The most northerly town in the center of the path that is on a railroad is Monet, in Latitude 48° 15', on the Canadian National Railroad. It is about 230 miles northwest of the city of Quebec.

The path of this eclipse as given in Oppolzer is greatly in error. It is about 700 miles too far to the northeast, coming down between Nova Scotia and Newfoundland. Mr. Seagrave of Providence first called my attention to the error some six or eight years ago and sent me the results of his computations. Since then I have received similar results from Dr. Comrie of the *British Nautical Almanac* and from Professor Eichelberger of the *American Ephemeris and Nautical Almanac*.

Five years ago Professor Todd began collecting weather observations for this eclipse. In 1926 I was asked to take over the work.

The observations consist simply in noting the condition of the sky at eclipse time, about 3:30 Eastern Standard Time, on each day from August 16 to September 16, approximately two weeks before and after the date of the eclipse. Numbers from 0 to 4 were used. A zero meaning totally cloudy, and 4 perfectly clear. These numbers were later translated into percentages of clear sky.

Observations have been received from 107 different stations, scattered all the way from Fort George on Hudson Bay to Provincetown on the tip end of Cape Cod. These include the government weather bureau stations at Portland, Montreal, and Quebec; Harvard College Observatory, McGill College Observatory; Coast Guard Stations, Light Ships, and Light Houses; municipal water and power stations, experiment stations and research laboratories (e.g. the General Electric Co. at Lynn, Hammond Radio Laboratory at Gloucester, and the Research Department of the Brown Co., Berlin, N. H.). The list also includes several small colleges, seminaries, convents, and high schools. In addition, many individuals have contributed generously of their time, postmasters, hotel proprietors, bankers, and other busy men.

Figure 3 gives a graphical summary of the results of five years observations. I have grouped the stations as shown and have used only those records that were complete and seemed to be most reliable.

The heavy line gives the percentage of clear sky for 32 days, August 16-September 16 for the five years 1925-1929. These points have different weights. The point for Hudson Bay is based on one record only; the Province of Quebec, 8; New Hampshire and Vermont, 5; Maine Inland, 4; Maine Coast, 15; Cape Ann, 6; Cape Cod, 3. I have marked two isolated points. The one under Maine is for the islands off the Maine Coast, Matinicus, Monhegan, Damariscove, Boon Island, and the Isle of Shoals. I had hoped that one of these might be near the center line, but that is not the case. Matinicus and Monhegan are just outside the northern limit, the others inside, but near the edges. The percentage for these islands is almost the same as for the coast stations. The other point, under New Hampshire, is for the summit of Mt.

Washington. Conditions there are about ten per cent worse than for neighboring stations at lower levels.

If we look along the graph there seems to be a slight slope as if conditions were somewhat better as we came down from Hudson Bay and approach the coast, but Hudson Bay is relatively inaccessible, and Cape

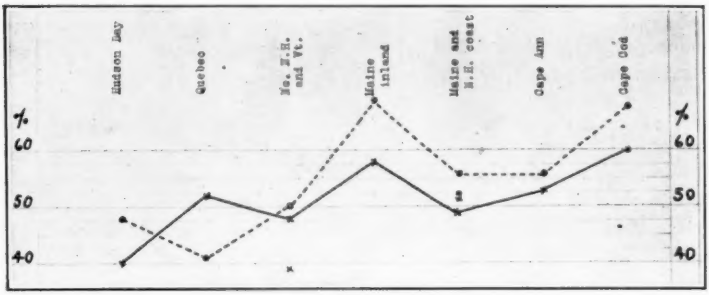


FIGURE 3.

PERCENTAGE OF CLEAR SKY AT 3:30 P.M. ALONG THE PATH OF TOTALITY OF THE ECLIPSE OF AUGUST 31, 1932, FROM FIVE YEARS' OBSERVATIONS, 1925-1929.

(Full line, mean for 32 days, August 16-September 16. Dotted line, mean for 7 days, August 28-September 3.)

Cod is rather far from the center line, so we may consider only the five intermediate sections. There is very little difference; 52% is a fair average for the 32-day graph and 55 for the 7-day graph. If these departures are real it means that the best place to locate is some distance back from the Maine coast, perhaps between East Baldwin and Fryeburg.

The "cloudiness" in this whole section may be due to one of four causes. First, to storms that travel along the northern boundary of the United States and pass out the St. Lawrence Valley. These storms av-

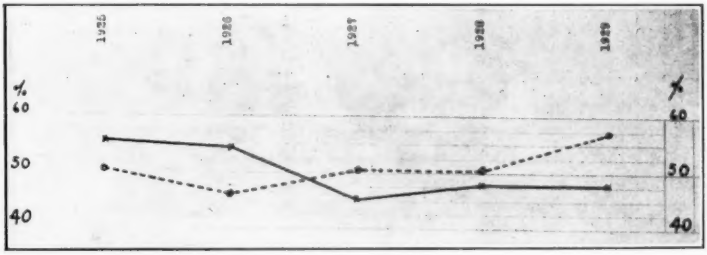


FIGURE 4.

COMPARISON OF THE PERCENTAGE OF CLEAR SKY FOR DIFFERENT YEARS ALONG THE PATH OF TOTALITY OF THE ECLIPSE OF AUGUST 31, 1932.

(Full line, stations along the Maine and New Hampshire Coasts. Dotted line, stations in northern New Hampshire and Quebec.)

erage one or two per week, and each lasts about 24 hours. They are accompanied by rain and moderately strong southeast to southwest winds. Secondly, to storms that come from the Gulf of Mexico or Caribbean Sea. There are generally one or two of these storms in September but they are relatively rare in August. They last about three days and are accompanied by heavy rain and very strong northeast to northwest wind. Third, to local fog. This sometimes forms during the latter part of the night, generally evaporates before noon, but occasionally lasts all day. Fourth, to convectional clouds. If the forenoon is clear and hot, cumulus clouds may form in the afternoon of sufficient density to obscure the sun.

It occurred to me that it would be interesting to see how the different years compared. Every year I receive comments on the reports, apologizing for the poor record and saying that "this has been a particularly bad year."

The curves in Figure 4 do not show any great departures. The heavy line from 20 coast stations shows a slight drop in the percentage of clear sky from 55% in 1925 to 48% in 1929. The inland stations show an increase from 48% to 58%.

In the fall of 1931, a summary for seven years will be published, but it does not look from Figure 4 as if the figures will be appreciably altered. Apparently it will be safe to count on a 50-50 chance.

ZODIACAL LIGHT AND MAGNETIC STORMS*

By E. O. HULBURT.

From April, 1853, to April, 1855, Rev. George Jones, U.S.N., observed the zodiacal light every night, weather and other things permitting. A comparison of his record with the Greenwich magnetic storm list gave the following results: In this period there were 26 magnetic storms, or storm groups, and 23 periods of abnormal zodiacal light, 16 of which followed within 3 days after a magnetic storm. Ten storms occurred on dates for which there were no zodiacal light observations, and there were 7 cases of abnormal zodiacal light with no accompanying magnetic storms listed. The abnormalities in the light were mainly fluctuations, and sometimes an unusual brilliance in the heavens. In the years 1911 to 1929 mention was found of five cases of abnormal zodiacal light. Four of these followed closely after magnetic storms, the fifth occurring at an epoch of magnetic calm. All in all the data give a rough average interval of less than two days for the lapse of time between the storm and the zodiacal light manifestation.

Of course abnormalities in zodiacal light may at times be due to local causes, such as variations in haze, etc., rather than to changes in the

*Summary of paper given at the December, 1929, meeting of the American Physical Society.

source of light itself, and in such cases there would be no connection between the zodiacal light behavior and magnetic disturbances. The foregoing facts which have been brought out, however, support the conclusion that the connection is genuine, and this suggests that zodiacal light is subject to the same influence as that which gives rise to the magnetic storm. The recent ultra-violet light theory of aurorae and magnetic storms attributed these phenomena to the action of molecules and ions of the earth's atmosphere under the influence of pulses of ultra-violet light from the sun. The extension of the theory to the zodiacal light may be done in two ways leading to two theories of zodiacal light behavior, each containing, however, very interesting difficulties.

The first theory assumes the view taken in certain textbooks that the zodiacal light is sunlight scattered or reflected from a great ring of particles around the sun in the plane of the ecliptic extending outside of the orbit of the earth. The ultra-violet solar flares which cause the magnetic storm would be supposed to render the ring of particles unusually luminous. This view requires that the zodiacal light be fluorescent light stimulated in the particles by the solar ultra-violet light and not reflected or scattered sunlight. The spectrum of the zodiacal light should therefore be different from that of sunlight, and yet the observations indicate that the two spectra are much the same. However, the zodiacal spectra were obtained with low dispersion, and the character of the spectrum is probably not known completely at the present time.

The second theory assumes that the zodiacal light comes from particles originating in our own atmosphere, an idea advanced long ago by Barnard and others. Fast flying atoms or molecules are sprayed out in all directions from the sunlit hemisphere of the earth, which after a number of hours are ionized by the sunlight. Once ionized they are guided by the magnetic field of the earth. Some of the ions may reach, or be formed at, levels above 50 thousand miles. Due to the action of solar radiation pressure and the earth's magnetic and gravitational fields there will be a concentration of ions, probably very rare, at high levels roughly in the plane of the ecliptic. The zodiacal light is the sunlight absorbed and re-emitted from the ions. The ultra-violet flare will cause changes in the number of the ions and in the light which they send down to the earth. The ions form a sort of an oblong ring around the earth which on the day side is perhaps 50,000 miles away and which on the night side stretches out to great distances. At the far end the ions continually stream away in the direction of the sun's rays, so that the ring merges into a sort of comet's tail which may be the Gegenschein.

REVEREND WALTER A. MATOS

By JOHN A. MILLER.

On August 9, 1929, Reverend Walter A. Matos died, after a brief illness in the Episcopal Hospital, Philadelphia. His death occasioned a severe loss to several institutions to which he had given his interest, his devotion, and his labors. One of these is the Sproul Observatory. He had been a volunteer observer at the Observatory from 1915 until his illness and carried a regular and definite part of the program of making photographs for the determination of stellar parallax. This valuable assistance was prompted entirely by his love for and interest in astronomical science. On three different occasions he was an acting instructor in the Department of Mathematics at Swarthmore College. The entire staff miss his counsel and his good fellowship.

During the college year Sproul Observatory is open to visitors two nights each month. Mr. Matos assumed a part of the responsibility for these visitors nights. His personality and his interest made him a charming and delightful host on the evenings that he presided at the telescope.

Mr. Matos was a student and a graduate of Central High School, Philadelphia, where he came under the tutelage of Professor Monroe B. Snyder, who not only taught him but also put at his disposal the very excellent instruments of that reasonably well-equipped Philadelphia Observatory. He acquired an accurate knowledge of the fundamentals of astronomy and an appreciation of its problems, both old and new. He was an accurate observer. His interest in astronomy never flagged. He was familiar with astronomical literature. He knew as many facts, not only the significant ones but the insignificant ones too, of the development of American astronomy as anyone of my acquaintance. He was a member of the American Astronomical Society, a Fellow of the Royal Astronomical Society, a member of the British Astronomical Association and a member, and for many years secretary-treasurer of the Rittenhouse Astronomical Society of Philadelphia.

His real life work, however, was not that of an astronomer, but that of a rector in the Protestant Episcopal Church. He served as rector of the Trinity Church of Swarthmore continuously from 1918 until his untimely death. He was a devoted and successful rector, not only ministering to the adults of his parish but even to a greater extent to its boys and girls. His study was a rendezvous for boys and girls in their teens. It contained, of course, a library but in addition numberless scientific instruments and scientific curiosities of just such a nature as would fascinate a boy. Very frequently older ones were replaced by newer ones. Each of his little guests selected his own instrument and operated it. It was an inspiration to see him without any apparent effort

lead these youngsters in an exploration of the physical world. Many of the boys who came out of that little study afterward chose scientific careers. No other one man had greater influence with the boys and girls of Swarthmore than did Walter A. Matos.

I have never seen any more touching devotion than that of his to his mother. Together they made a home and lived for each other.

SWARTHMORE, PENNSYLVANIA, FEBRUARY 4, 1930.

LONGITUDE OF THE JOHN PAYSON WILLISTON OBSERVATORY

By ANNE S. YOUNG.

Data for the re-determination of the longitude of the John Payson Williston Observatory of Mount Holyoke College were secured at the time of the world longitude campaign in 1926. No earlier determination had been definitive.

During October and November, the special time-signals from Arlington on 74.7 meters at 15:20 and 22:20, E.S.T., were recorded on the chronograph as well as the regular signals at 21:55. On the same chronograph were recorded sets of time-stars observed with the 3-inch meridian-circle.

The final longitude is based upon 46 five-minute groups of signals received on 23 days when both signals and time-stars were secured. The weighted mean value of the difference in longitude from Washington is $-17^m\ 56^s.79 \pm 0^s.01$ which combined with the Washington longitude as published in the *American Ephemeris* for 1929 gives $4^h\ 50^m\ 18^s.99$ as the longitude of this observatory.

Most of the observations were made by Miss Alice H. Farnsworth; the greater part of the work of reduction was done by Miss Catherine Stillman.

AMERICAN ASTRONOMICAL SOCIETY

REPORTS OF OBSERVATORIES
1928-1929

(Continued from page 159.)

GOODSELL OBSERVATORY

CARLETON COLLEGE

Professor Gingrich was absent on leave during the first semester and spent most of the time in Europe. While there he attended the meetings of the International Astronomical Union at Leiden and the Astronomische Gesellschaft at Heidelberg.

Mr. Harold F. Balmer resigned as instructor in astronomy in June

of 1929 and Dr. Louis Berman was appointed to fill the vacancy.

The main work of the staff, as usual, consisted in teaching the various college classes in astronomy. The enrollment in these classes amounted to over ten per cent of the students in the college.

Time-signals for the railways of the Northwest were sent out daily.

The photo-electric photometer was used on a number of variable stars and certain parts of the instrument were calibrated. No regular observing program was undertaken.

The number of bound volumes in the library was increased by 197.

The observatory was open to the public one night in each month.

E. A. FATH, *Director.*

OBSERVATORIO ASTRONOMICO

UNIVERSIDAD NACIONAL

LA PLATA, ARGENTINA

(July, 1928-June, 1929)

Personnel. Dr. Hartmann, having completed his six years contract as Director of the Observatory, returned to Göttingen in October, 1928, but, being re-elected in December, he came back in April, 1929. During this interval Mr. Dawson was Acting Director. From June to August, 1928, Mr. Dawson went to Europe and took part in the congresses of Leiden and Heidelberg. Astronomer Numa Tapia left La Plata in April, 1929, on fifteen months' leave for study in Germany.

Researches. Astronomer Manganiello continued the revision of the Zone La Plata D —66° to —72°. Astronomer Martinez finished a second series of two observations each of the southern Eros stars, so that now all the stars south of —10° have been observed at least four times. Series of observations of Comet Forbes 1928*c* and of micrometric measures of double stars were secured by Mr. Dawson with the large refractor. Both he and Señor Dartayet continued their observations of occultations and of long-period variable stars. The routine services of time-signals, meteorological observations, etc., have been continued.

The seismological section, in charge of Dr. Lunkenheimer, continued its activity with continually increasing success.

Publications. There were printed and distributed: *Publicaciones* vol. VI, No. 5: J. Hartmann, Nueva Determinación de la Longitud Geográfica del Observatorio Astronómico de la Universidad Nacional de La Plata; *Publicaciones* vol. VII: Félix Aguilar y Bernhard H. Dawson, Catálogo La Plata B de 7792 estrellas de declinaciones comprendidas entre —57° y —62° (1875) para el equinoccio 1925; *Contribuciones Geofísicas* vol. II, No. 3: J. Hartmann, Dos aparatos para facilitar la determinación de los epicentros sísmicos; *Contribuciones Geofísicas* vol. II, No. 4: F. Lunkenheimer, Método mecánico-gráfico para determinar el epicentro en base de tres observaciones de P; *Contribuciones Geofísi-*

cas vol. II, No. 5: F. Lunkenheimer, Elementos nuevos para la determinación de los epicentros.

Besides there were published several articles and notes in various periodicals.

J. HARTMANN, *Director.*

LEANDER McCORMICK OBSERVATORY

UNIVERSITY OF VIRGINIA

The program for trigonometric parallaxes goes on without substantial changes other than those necessitated by certain stars being finished and others being added to the observing list. During the year, 2180 plates were taken for parallax and proper motion. On December 1, 1929, a total of 980 parallaxes had been completed, and hence the thousandth parallax will become a reality during the coming spring. Heretofore the parallax program has been made up mainly of the brighter stars and those of large proper motions. The additions in the immediate future will be stars of medium proper motion of approximately 0".20 per year and also visual binary stars. As stated several times already, the McCormick Observatory is always glad to add to its observing program any star in which any astronomer has a special interest.

The various projects for proper motion are being continued. Two plates, each with two images, have already been taken on 150 Cepheids. During the year another class of stars was added to the observing program, namely, long-period variables. At the McCormick Observatory the variables north of —10° declination will be photographed, while at the Yale Observatory station in Johannesburg the regions to be photographed will lie south of +10° declination. At the McCormick Observatory, on December 1, 1929, a total of 115 regions, each with two plates and two images, had already been photographed. The purpose of these proper motions, both on the Cepheids and on the long-period variables, is to obtain information in regard to their parallaxes, and hence to derive further knowledge about the period luminosity law.

During the summer of 1929, the director spent two months at the Mt. Wilson Observatory working on the revision of the spectrum of the chromosphere soon to be published.

On October 1, 1928, Dr. Sten Asklöf of Upsala joined the staff as Vanderbilt fellow.

S. A. MITCHELL, *Director.*

LICK OBSERVATORY

UNIVERSITY OF CALIFORNIA

MOUNT HAMILTON, CALIFORNIA

The 36-inch refractor, during the year 1928-1929, was devoted mainly to spectrographic work, and particularly to the measurement of stellar radial velocities. One program, initiated early in the year by Mr.

J. H. Moore, contemplates the observation of about 835 stars of spectral classes F to M and of photographic magnitudes 8.5 to 8.6 with a 1-prism spectrograph having a linear dispersion at Hγ of about 75 A per mm. The stars on this program have been selected and charted for convenience in identification, care being taken to include approximately the same number for each spectral class as recorded in the Henry Draper Catalogue, and to secure a fairly uniform distribution of the stars over the sky. It is planned to take three spectrograms of each star, and during the year, a good beginning was made, the actual record being 267 plates. Measures of these by Mr. G. F. Paddock, who has also taken an active part in the observing program, indicate that the probable error of a single observation is ±2 km/sec, an order of accuracy which is quite satisfactory in view of the low dispersion, and is sufficient for statistical studies of the motions of these stars. The spectrograms secured will also be utilized for the determination of the absolute magnitude of these stars.

Polaris, α Cygni, and half a dozen other interesting spectroscopic binary stars were observed with the 3-prism Mills spectrograph, by Mr. Moore and Mr. Paddock, to secure additional data for orbit determinations. In all, 321 plates were taken, 56 of them being of Polaris. In addition to Messrs. Moore and Paddock, Messrs. Menzel, Krieger, and Berman took part in the observational work on these two programs, and Miss Rebecca Jones spent most of her time in the work of plate measurement and reduction. Other spectrographic work with the 36-inch refractor includes 163 spectrograms taken with the 1-prism spectrograph by Mr. Trumpler, in continuation of his program for the investigation of the open star clusters, to which fuller reference will be made in a later paragraph, and about 51 plates with spectrographs of from one- to three-prism dispersion, chiefly by Mr. Menzel in continuation of his studies of planetary and nebular spectra.

It will be of interest to make special note of the work on Polaris. Ever since the discovery by Dr. W. W. Campbell, in 1899, of a long-period variation in the radial velocity of this star, a series of 3-prism spectrograms has been secured at least once a year to determine the period of variation and the other orbital elements. The plates taken in the years 1927-1929 show that the star is, for the first time, repeating its passage through the part of the orbit traversed in 1896-1899. Utilizing approximately 700 of our 3-prism spectrograms, Mr. Moore has made a preliminary investigation of the orbit. He finds that Polaris and its invisible companion are revolving in quite eccentric orbits ($e = 0.63$) about their common center of gravity in a period of 29.6 years. Since Polaris is also a Cepheid variable, with a period of 3.97 days, it is possible to determine not only its absolute magnitude, but also its mass. The absolute magnitude is −1.8 and the mass 8.50. From his orbit of the long-period pair, Mr. Moore has shown that in all probability the maximum apparent separation of the two components is about 0″.5, and that the companion is from four to five magnitudes fainter than the bright star.

The chances are, therefore, that the pair cannot at any time be observed as a visual double star with any existing telescope.

Reference should also be made to the fact that Mr. Paddock has devoted much time to the measurement of the three-prism spectrograms, and to the investigations of the orbits of some of the spectroscopic binaries—of α Cygni and 64 Piscium, in particular. Further, the systems κ Arietis and σ Librae were investigated by Miss Jones. Since these investigations are still incomplete, comment is reserved.

Mr. Aitken continued his program of remeasuring all the double stars of his own discovery at a third epoch and secured 400 measures with the 36-inch refractor during the year. A few miscellaneous pairs, chiefly close pairs in rapid motion, were also measured. Work on the general catalogue of double stars was continued, with the able assistance of Mrs. J. H. Moore. The manuscript of the main body of the work was completed, except for the notes of the measures in the last six hours of right ascension. In addition to preparing these, it remains to make a thorough check of the copy, including a check of the star places, and to write the general introduction. It is estimated that this can be done by the end of March, 1930. It is hardly necessary to add that the attention that had to be devoted to administrative work made sad inroads upon the time available for this and other research work.

Mr. Wright was on leave from April 15 until December 1, 1928. His time during this interval was largely given to attendance at scientific meetings, including the Leiden meeting of the International Astronomical Union, in July, and to visiting astronomical observatories abroad. On his return he resumed his general investigation of the brighter planets by monochromatic photography, utilizing the Crossley reflector in securing photographs of Mars, and discussing photographs of the Moon and of Jupiter, secured by Mr. Moore, Miss Dorothy Applegate, Mr. J. F. Chappell, and himself. These discussions resulted in two papers, one giving a brief account of the outstanding chromatic peculiarities of the lunar surface, the other describing the alterations in the appearance of Jupiter in the late summer and autumn of 1928. Mr. Wright received the honorary degree of Doctor of Science from Northwestern University at the annual Commencement in June, 1929.

Reference has already been made to Mr. Trumpler's work on the open star clusters. In addition to the spectrograms noted, 62 plates were taken with a 4-inch Ross objective mounted on the Crocker telescope, for comparisons of cluster stars with stars of the North Polar Sequence, to determine the magnitudes of the former accurately. Each cluster is compared also with three or four other clusters. The observations are now complete for 38 clusters, and much work has been done on plate comparisons and reductions.

From the extensive, though still incomplete, material at hand, a preliminary investigation was undertaken of the distances, dimensions and space distribution of the open clusters. Distances could be derived for 80 clusters from the magnitudes and spectral types; for 88 others, relia-

ble estimates could be made from the apparent diameters combined with a classification of structure and composition. It appears that the space distribution of the open clusters is simlar to that of the stars in general. The clusters outline a lens-shaped region of space about 10,000 parsecs in diameter and 1200 parsecs thick, with a well marked local grouping in the neighborhood of the Sun, and some indication of special structure in the outer parts. In connection with this work, the preparation of a new catalogue of star clusters has been begun, since it was evident that a revision of those listed in the N.G.C. was necessary.

Mr. Trumpler also made visual and photographic observations of Mars in January and February, 1928, but the conditions were unfavorable, and only a few of the observations are satisfactory.

In August, 1927, as noted in last year's report, Mr. Jeffers began actual observation with the Repsold meridian circle on a list of 1174 stars to serve as reference stars for Dr. Schlesinger's photographic reobservation of the A.G. zones from $+20°$ to $+30°$. This program of work was continued actively during the first half of the year under review, but could not be completed. For 321 stars the three observations desired have been secured; 623 others have been observed twice and the remaining ones only once. The measurement of the chronographic records was kept up to date, and, with the assistance of Miss Phyllis Hayford, the reduction for the standard stars was partially completed for about one-third of the observed zones.

The Shortt Free-Pendulum Clock, to which reference was made in last year's report, was set up on January 10, 1929, and the investigations to date (June 30, 1929) indicate that it will prove to be very satisfactory. The Riefler Clock was dismounted a little later in the year and part of the works sent to the makers for adjustments. Minor changes in the transit micrometer and in clocks and radio-receiving apparatus have resulted in increased accuracy of the various observations.

Mr. Jeffers was in residence in Berkeley from the early part of January to the middle of June, giving instruction in the Berkeley Astronomical Department, and his place here was taken by Professor Sturla Einarsson, of that department. Mr. Einarsson, while on the mountain, took charge of the clocks and time service, engaged in observations of comets and minor planets, and in theoretical researches.

In addition to spectrographic work with the 36-inch, mentioned in earlier paragraphs, Mr. Menzel secured a number of photographs of nebular spectra with the Crossley reflector. His time during the year, however, was devoted chiefly to a study of the flash spectrum. Various theoretical problems related to the physical interpretation of this spectrum and to the constitution and equilibrium of the chromosphere engaged his attention, among them an investigation of the generalized ionization and equilibrium formulae for hydrogen, based on the new wave mechanics. The solutions reached will be of more or less general physical interest as well as being essential to his work on the flash spectrum. This piece of research will be completed during the coming

year.

The second A. Cressy Morrison Prize offered by the New York Academy of Sciences for the best paper on the sources of solar and stellar radiation, was awarded in December, 1928, to the paper by Messrs. B. P. Gerasimovič and Menzel entitled "Sub-atomic Energy and Stellar Radiation." It will be recalled that the first A. Cressy Morrison Prize for the best paper on this subject was awarded to Mr. Menzel in 1926.

Mr. N. T. Bobrovnikoff, Martin Kellogg Fellow, continued his researches on the constitution of comets and the tail structure of comets, and on such related problems as the spectra of the minor planets. An appointment as Fellow in Physics and Astronomy under the National Research Council, will enable him to continue his studies along these lines at Berkeley during the present year, and publication of the results of the entire research may be expected after the close of the year.

Three Lick Observatory Fellows were in residence during the year, Mr. C. J. Krieger, Mr. Louis Berman, and Miss Lois Slocum, chiefly engaged in work for their theses for the Ph.D. degree. Miss Slocum is taking another year for her work and reference to her research is therefore deferred. Mr. Krieger made a determination of the magnitudes, spectral types, and color indices in the Scutum Cloud, having secured his observational material, consisting of 132 photographs and spectrograms, with the Crossley reflector. A statistical discussion of his material provided interesting results relating to the distance and dimensions of the Cloud, and to the density and the distribution of the stars of which it is composed.

Mr. Berman used the slitless spectrograph attached to the Crossley reflector to secure about 200 spectrograms for a photometric study of the planetary nebulae. His investigation, like Mr. Krieger's, was completed during the year and both papers will be published as *Lick Observatory Bulletins*. The Ph.D. degree was awarded to both Mr. Krieger and Mr. Berman at the annual Commencement of the University of California in May, 1929.

Ten Lick Observatory *Bulletins* in addition to many articles in various journals were published during the year and a number of public lectures were given by different members of the staff.

R. G. Aitken, *Associate Director.*

LOWELL OBSERVATORY

Flagstaff, Arizona

The visual and photographic study of the planets Saturn, Jupiter, Mars, Venus, and Mercury, has been continued by Mr. E. C. Slipher. Special attention was given to large scale photographs, magnification 150 to 215, with the 24-inch refractor and color filters. Since 1904 yellow photographs have been taken here at each opposition of Saturn,

Jupiter, and Mars with the same kind of filters and plates, therefore these again formed a principal part of the planetary observations in order to maintain this homogeneous record. However, plates and filters of various spectral ranges were used for red, yellow, blue, and ultra-violet photographs. About 400 plates of multiple images were secured, the plates being distributed over as long a period of time as practicable.

Saturn was photographed over an extended period, mostly in yellow and blue light, although some red and ultra-violet plates were made. Red and violet photographs continue to show striking differences in the ball. Also notable differences occur in the violet images taken from year to year. The matter of correlating changes on Saturn and Jupiter and the possibility of connecting these variations with other influences in the solar system are receiving attention.

Jupiter was observed quite regularly from mid-September to mid-January and some 160 plates were secured, mostly in yellow and blue light, with occasional ones in red and ultra-violet. The record of the great transformation which occurred on Jupiter in the autumn of 1928 should be of special value eventually in interpreting Jovian phenomena.

The observations of Mars in December mark the twelfth consecutive opposition photographed at Flagstaff, and the sixteenth observed visually. Emphasis was placed on yellow and blue photographs, with some red and ultra-violet ones to supplement the visual observations. Although the apparent disk was small, many changes were recorded (POPULAR ASTRONOMY, **37**, 327, 1929). With a few exceptions these conformed to the seasonal behavior previously observed here.

Ultra-violet photographs of Venus with a Jena (U.G.2) u-v filter were continued with considerable regularity, when her position permitted photography in ultra-violet, from October, 1928, to April, 1929, 16 days before inferior conjunction. Effort was made to extend these photographs over as much of the planet's orbit as possible with a threefold purpose; first, for detecting seasonal variation in the markings, which should manifest itself in case the planet's axis were considerably tilted to the orbital plane; second, for increasing the chance of obtaining some outstanding markings giving positive evidence of the planet's rotation; third, for ascertaining the altitude of the reflecting medium producing the dark and bright markings in ultra-violet by photographing near inferior conjunction when differences in elevation should be greatly magnified, resulting in terminator projections and excessive prolongation of the cusps, if the ultra-violet features lie higher than the general reflecting surface. The work is incomplete and the quality of the photographs not all that could be desired, since they were necessarily often made in considerable daylight and under otherwise adverse conditions, but so far no definite seasonal variation or rotational effect has been established, nor do the results indicate that the ultra-violet light was reflected from higher levels than the longer wave-lengths. The changes recorded were quite chaotic, often major markings appearing or disappearing from day to day, and probably of sufficient magnitude

in themselves to mask slow rotational effects. There is some indication that roughly similar markings appear or recur at intervals of about 30 days, but it is not possible to decide whether this is due to rotation or not.

Some observations of Mercury, including photographs, have been made.

Numerous experiments on photography of terrestrial objects and materials have been made to aid in the interpretation of the planetary results.

The usual lines of spectrographic work have been continued. The following spiral nebulae and globular star clusters have been observed for determining their radial velocities: NGC 4406, NGC 4414, NGC 6254, NGC 6402, NGC 6656, and NGC 6705.

Two series of spectrograms, with the special night-sky spectrographs, were secured of the auroral display of July 7, using both isochromatic and red sensitive plates. It was found that the red emission near 6320 A, first photographed here in 1921, was very strong, much outshining the chief auroral line 5577 A and little fainter than the strongest nitrogen bands. This red emission is composed of at least two members, of which the more refrangible is the weaker. These spectra also record an interesting sharp line near 5206 A (resembling the chief line 5577 A) the intensity of which appeared not to change with the nitrogen bands through the different exposures. Also spectrograms on panchromatic plates were secured at our mountain station of the remarkable aurora of October 18. This aurora was exceptionally red, and the spectral analysis of its light showed only the one red emission near 6320 A until the last exposure before dawn, when the usual auroral bands of nitrogen made a weak appearance. Through the series, the chief auroral line (5577 A) was scarcely, if at all, influenced by the display.

Observations at the Observatory and at the Mountain Station on the night-sky spectrum early in the year revealed a remarkable series of prominent emissions in the lower spectrum from the aurora line 5577 A (including the line near 5893 A first detected here on sky spectra of 1922) to 6700 A, with traces of others still farther in the red. The high intensity and number of these new emissions compared with those earlier found in the photographic portion of the spectrum would make the night sky appear orange-red if it were not too faint for the eye to recognize its color. The observations indicate these emissions are always present, but in varying intensity. They appear to vary somewhat among themselves and at least that near 5893 A does not vary with the chief auroral line 5577 A. Among them is one that may be related to or identical with the emission 6320 A observed here in the auroral displays of May 14, 1921, and the two of 1928.

Radiometric measurements on the planets, supplemented by many series of measurements on the sun and stars, have been carried on by Mr. Lampland, assisted by Mrs. Lampland. This part of our observational program was considerably interrupted by Mr. Lampland's ab-

sence in Europe during the summer of 1928 and his residence at Princeton University during the winter and spring of 1929. Measures on Mercury, Venus, the Moon, Mars, and Jupiter have been continued. The planetary measures have been made with the 42-inch reflector at the Newtonian focus, and with mirror combinations of 53 feet and 80 feet equivalent focus. Transmission measurements of the sun have been made with a special radiometer, at the Observatory in Flagstaff, together with two days observations at our high altitude station. The reductions of the measures are considerably in arrears, but much of the numerical work is well along and is being advanced as rapidly as the limited time of the observer permits.

Some color-filter photographs of Mars and Jupiter have been made with the 42-inch reflector for comparison with those made with the 24-inch refractor.

Important improvements have been made to obtain more complete analysis of the radiometric data. Three additional transmission screens have been employed, supplementing the water cell, in order to more completely analyse the solar energy reflected by the planets.

The 15-inch reflector has been provided with a radiometer for measuring the integrated radiation of Venus. Carried on practically simultaneously with measures with the 42-inch reflector equipped for analysis of the radiation from different parts of the disk, the smaller instrument offers a valuable check on results obtained with the large reflector.

Several thermopiles and thermocouples for special problems have been constructed, including a new form for the direct measurement of surface temperature in certain field and laboratory investigations. A recording microphotometer was completed and tested. Much work has awaited this instrument in the measurements of spectra and planetary photographs.

During the year the new photographic telescope was completed and has since April been regularly in use. It performs very satisfactorily and is conveniently operated. It has a powerful driving clock, a large worm wheel and sturdy double piered polar axis, permitting, if desired, a full night's exposure without interruption, the observer having switches for the dome and guiding motors in hand at the guiding eyepiece. The objective of 13 inches aperture and about 64 inches focus is of the three element astro-type. It came from the skillful optician, Mr. C. A. R. Lundin. The field of good definition is surprisingly large, covering with practically perfect definition the full width of the 14x17 plate. A special plate holder and testing table were developed, which enable the observer in a minute's time to adjust the plate's sensitive surface always accurately to a pre-determined relation to the focal surface of the lens, regardless of the considerable variation in the curvature or thickness of glass of such large plates.

Dr. Percival Lowell gave much time during the last decade of his life to a study of the evidence for a trans-Neptunian planet (*Memoirs*

of the Lowell Observatory, **1**, No. 1, 1915). As early as 1906 the photographic search was begun in those parts of the ecliptic which his work indicated to be promising, but it had to be done with instruments not well suited to the task. Thus it has been with satisfaction that the Observatory could this year renew the search with an efficient instrument. In this search, exposures are being made along the ecliptic in a widened belt where Lowell's work indicated the planet might be. The plate of each region is duplicated after some nights, and the work is carefully systematized to insure plates as identical as possible, thereby facilitating their examination in the blink-comparator.

During the summer of 1928 Mr. Lampland was the Observatory's delegate at the meeting of the International Astronomical Union in Leiden, and for the second semester in 1929 was exchange Professor in Astronomy at Princeton University. Dr. Raymond S. Dugan, with his family, came to Flagstaff late in January for six months residence. While here Dr. Dugan was occupied with carrying forward his researches on variable stars.

Mr. C. W. Tombaugh joined the staff in January as assistant. His chief duties have been with exposures at the photographic telescope.

V. M. SLIPHER, *Director*.

[*To be continued.*]

PLANET NOTES FOR MAY

By CLIFFORD E. SMITH.

The *Sun* will be moving northeast from the central part of Aries to the central part of Taurus. The positions of the sun on the first and last days of the month will be, respectively: R.A. $2^h\,30^m$, Decl. $+14°\,47'$; and R.A. $4^h\,28^m$, Decl. $+21°\,47'$.

The phases of the *Moon* will occur as follows:

First Quarter	May	5 at 11 A.M.	C.S.T.
Full Moon		12 " 11 A.M.	"
Last Quarter		20 " 10 A.M.	"
New Moon		27 " 12 P.M.	"

The moon will be at perigee on May 4 and on May 31, and at apogee on May 19.

Mercury will be in western Taurus. Its apparent motion will be direct until May 9, and thereafter retrograde. Early in the month it will be an object of the first magnitude and will then set about an hour after the sun. Its phase during this period will be crescent. On May 20 it will be at inferior conjunction, and on May 26 it will pass through its aphelion point.

Venus will be an evening star, setting about two hours after the sun during the latter part of the month. It will be in the western part of Taurus at the beginning, but it will have moved to western Gemini by the end of the month. It will be of magnitude about minus 3.5, and its phase will be gibbous. It will be

in conjunction with Jupiter on May 17, pass through its perihelion point on May 25, and be in conjunction with the moon on May 30.

Mars will be in eastern Pisces. Its apparent magnitude will be between plus one and plus two, and its apparent motion will be direct. On May 12 it will be in conjunction with Uranus, and on May 25, in conjunction with the moon. During the middle of the month, it will be on the meridian about 9:30 A.M. Standard Time.

Jupiter will be in eastern Taurus, and its apparent magnitude will be about minus one and one-half. Its apparent motion will be direct. On May 1 and May 29 it will be in conjunction with the moon, and on May 17, in conjunction with Venus. Jupiter will be on the meridian about 2:00 P.M. Standard Time on May 15.

Saturn will be in central Sagittarius. Its apparent motion will be retrograde, and its apparent magnitude will be about plus one-half. On May 16 it will be in conjunction with the moon, and on May 17, in conjunction with Venus. On May 15 Saturn will transit the meridian about 3:20 A.M. Standard Time.

Uranus will be in central Pisces, and its apparent motion will be direct. During the middle of the month it will rise about two and one-half hours before the sun. On May 12 Uranus will be in conjunction with Mars, and on May 24 it will be in conjunction with the moon.

Neptune will continue to be in Leo near Regulus, and its apparent motion will be retrograde. On May 22 it will be in quadrature east of the sun, and thus on that date it will be on the meridian about 6:00 P.M. Standard Time. On May 6 Neptune will be in conjunction with the moon.

Occultations Visible at Washington

[From the *American Ephemeris.*]

Date 1930		Star	Mag.	IMMERSION Washington C.T.	*a*	*b*	Angle E from N	EMERSION Washington C.T.	*a*	*b*	Angle E from N
				h m	m	m	°	h m	m	m	°
May	3	*c* Gem	5.5	23 13	+0.3	−1.4	113	0 2	+0.4	−1.1	279
	16	234 B.Sgr	5.9	22 40	−0.3	+1.1	98	23 50	−0.9	+1.2	268
	20	161 B.Cap	6.4	3 18	−1.4	+2.4	30	4 31	−2.3	+0.6	277
	30	134 B.Gem	6.5	19 40	−0.2	−1.4	105	20 35	+0.1	−1.4	284
	31	λ Cnc	5.9	19 44	+0.6	−3.1	166	20 20	−1.3	−0.3	240

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 or 300 miles of Washington. The procedure is as follows: Subtract the longitude of Washington (77°.1) from the longitude of the place in question; multiply the result, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude (38°.9) using *b*; apply the sum of the products, with its proper sign, to the Washington C.T., and obtain the predicted Washington Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to add 8.3 minutes to Washington Civil Time.

Central Eclipse of the Sun, April 28, 1930

A very interesting eclipse of the sun visible throughout the United States as a partial eclipse will occur on April 28. The eclipse will be annular along a path from the middle of the Pacific through northern California, Idaho, and Montana,

thence to a point southeast of Greenland. The tip of the conical shadow of the moon will touch the earth somewhat west of San Francisco and move northeast to a little southwest of Butte, Montana. Those within this shadow, the width

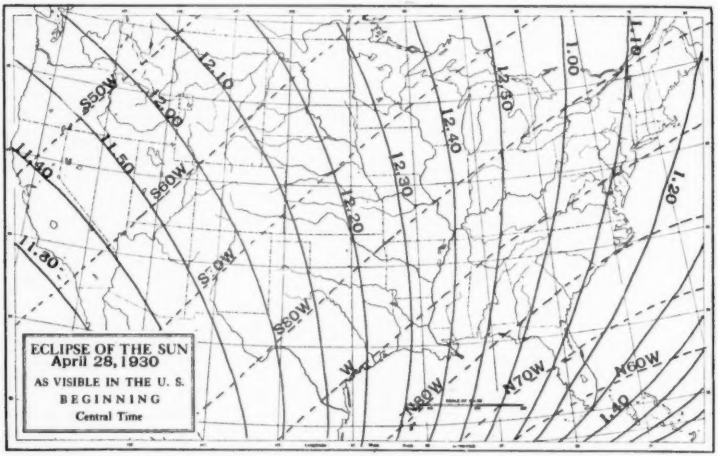


FIGURE 1.

of which is hardly a quarter of a mile, will witness a total eclipse lasting about one second.

Figure 1 gives the times when the moon first encroaches on the face of the sun and also the numbers of degrees from the north or south point of the sun the shadow will first appear. All points on the heavy dark lines will see the partial

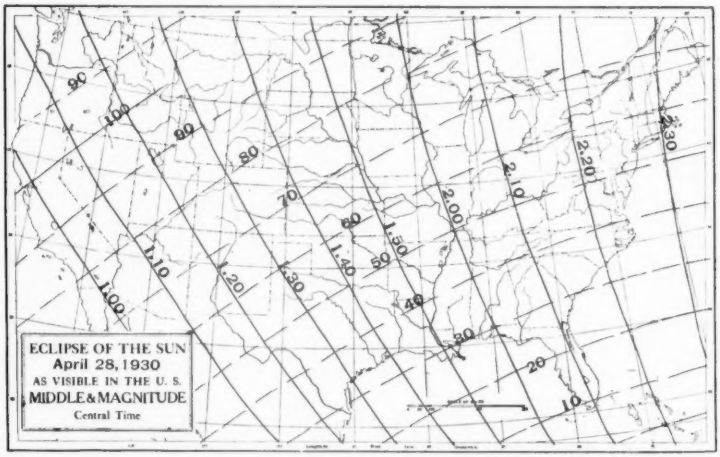


FIGURE 2.

eclipse begin at the time marked on these lines. The times to the nearest minute for places in between the lines may be obtained by interpolation. The time, for example, at Chicago is 12:43 (between 12:40 and 12:50). The broken lines indicate the position angles from the north or south point of the sun as explained above. For Chicago it is S 78 W, that is 78 degrees from the south point of the sun. Central Standard Time is used throughout.

Figure 2 gives the time of maximum obscuration at the various places and the percentage of maximum obscuration (the broken lines). At Chicago these are 64% at 2:06.

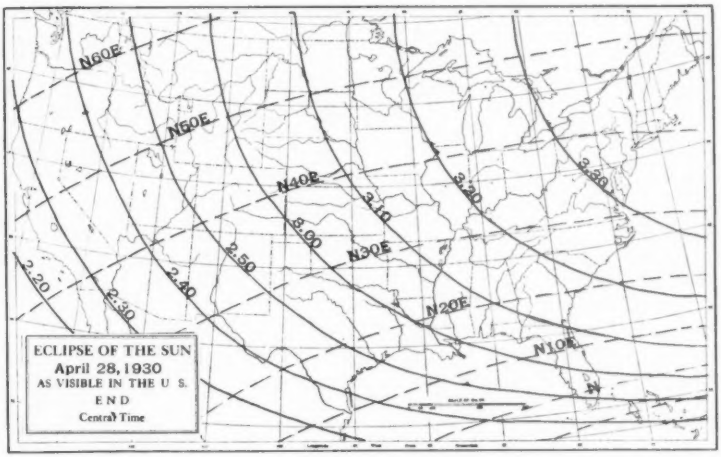


FIGURE 3.

Figure 3 is the same as Figure 1 for the ending of the eclipse.

Creighton University Observatory. WM. CLETUS DOYLE, S. J.

VARIABLE STARS

Monthly Report of the American Association of Variable Star Observers for February, 1930.

Congratulations are due our fellow member and variable star observer, Mr. L. C. Peltier of Delphos, Ohio, for his discovery on February 19 of a rather faint comet. Although subsequent information appears to indicate that the same comet was discovered a day earlier by astronomers at Bergedorf, Germany, Mr. Peltier, through the Yerkes Observatory, was the first to announce his discovery to the astronomers of this country. This is Mr. Peltier's fourth find, and when it is recalled that he still retains the title of "ace" variable star observer in America, such discoveries are all the more commendable.

After months of patient, waitful watching on the part of our observers, they were finally rewarded by finding U Geminorum rising to maximum late in Janu-

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1930.

Dec. 0 = J.D. 2425946; Jan. 0 = J.D. 2425977; Feb. 0 = J.D. 2426008.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V Scl	R And	RW And	U Scl	X Cas	T Per
000339	001838	004132	*010630*	014958	021258
953[14.0 Bl	002 9.2 Ah	981 12.0 Ch	965[13.5 Bl	999 12.6 Pt	000 8.5 BL
971[12.6 En	003 9.3 Ah	999 13.5 Pt	971[13.2 En	002 11.4 B	000 8.7 Ah
980 14.5 Dr	004 9.3 Ah	002 12.8 B	980 15.0 Dr	U Per	001 8.6 Ah
S Scl	005 9.4 B	V And	U And	015254	002 8.5 BL
001032	006 9.0 Fd	004435	010940	981 8.3 Ah	007 8.6 BL
950 7.9 En	S Tuc	981 9.6 Ch	978 10.0 Ch	983 8.1 Ah	008 8.5 BL
953 8.4 Bl	*001862*	X Scl	990 10.1 L	984 8.2 Ah	013 8.4 BL
955 8.9 Ht	965 13.3 Bl	*004435*	000 9.0 Lg	985 8.2 Ah	016 8.3 BL
965 9.0 Ht	966 13.2 En	953 11.7 Bl	UZ And	991 8.3 Ah	019 8.5 BL
965 9.2 Bl	971 12.8 Ht	965 11.4 Bl	011041	994 8.2 Ah	022 8.3 BL
966 8.5 En	977 11.4 Bl	973 11.2 En	978 11.6 Ch	996 8.2 Ah	Z Cep
971 9.4 Ht	983 10.8 Dr	977 11.2 Bl	002 9.6 B	997 8.3 Ah	021281
974 8.9 Dr	993 10.3 Dr	RR And	S Psc	998 8.2 Ch	988 11.0 L
977 9.3 Bl	005 10.2 Dr	004533	011208	999 8.3 Pt	998 10.6 Ch
983 9.1 Dr	S Cet	981 11.2 Ch	007[13.2 L	000 8.3 Ah	999 11.0 Pt
993 9.8 Dr	*001909*	002 9.8 B	S Cas	001 8.3 Ah	o Cet
999 9.8 Dr	975 8.7 Ch	RV Cas	011272	002 8.4 Ah	*021403*
999 10.0 Pt	991 8.5 Tf	004746a	982[13.2 Ch	003 8.4 Ah	949 8.8 Be
X And	991 8.8 L	981[13.2 Ch	999[13.0 B	005 8.4 B	967 9.0 En
001046	993 8.6 Sf	999 11.2 Pt	U Psc	XX Per	974 9.0 En
979[13.0 Lj	994 8.5 Ch	W Cas	011712	015654	981 9.1 Ah
981[13.4 Ch	998 8.6 Tf	004958	997[13.2 Ch	998 8.6 Ch	982 9.4 Ch
003[12.8 Lj	999 8.8 Pt	977 8.8 Ch	007[13.5 L	S Ari	983 9.1 Ah
T Cet	000 8.7 Tf	999 8.8 Pt	R Scl	015912	989 9.2 Ah
001620	002 8.6 Sf	999 8.8 BL	*012233a*	001[12.3 Md	990 9.2 Ah
982 5.8 L	008 8.7 L	000 8.9 BL	983 5.6 Dr	R Ari	990 9.0 L
991 5.9 Tf	T Scl	002 8.6 BL	994 5.7 Dr	021024	993 9.2 Ah
998 5.9 Tf	*002438a*	002 8.4 B	RZ Per	981 9.1 Ah	996 9.1 Ah
008 5.5 L	972 10.0 En	003 9.0 Jo	012350	982 9.0 Ch	997 9.1 Ah
T And	974 9.4 Dr	007 8.7 BL	978 9.4 Ch	983 9.0 Ah	999 10.0 Pt
001726	993 9.0 Dr	008 8.6 BL	996 9.3 Lg	984 9.0 Ah	999 9.4 BL
971[11.8 Md	999 8.7 Dr	009 9.2 Jo	R Psc	985 9.0 Ah	000 9.4 BL
981[13.7 Ch	RR Scl	013 9.0 BL	012502	989 8.8 Ah	000 9.3 Tf
996 13.8 Ch	*002438b*	016 8.8 BL	977 9.0 Ch	990 9.0 Ah	000 9.0 Ah
002 12.9 B	999 13.0 Dr	019 8.9 BL	981 9.3 Ah	990 8.9 L	001 9.1 Ah
T Cas	T Phe	022 9.0 BL	983 9.1 Ah	991 8.9 Ah	002 9.1 Ah
001755	*002546*	T Tuc	989 9.3 Ah	993 8.9 Ah	002 9.2 BL
990 8.9 L	953 13.6 Bl	*005475*	990 9.2 Ah	996 9.1 Ah	003 9.1 Ah
994 9.6 Ch	965 13.9 Bl	951 10.1 En	993 9.6 Ah	997 9.1 Ah	004 9.1 Ah
999 10.0 Pt	966[13.0 En	953 10.5 Bl	996 9.5 Ah	999 9.0 Pt	007 9.2 L
005 9.9 B	971[13.2 Ht	958 10.8 Ht	997 9.6 Ah	000 9.1 Ah	007 9.3 Tf
007 9.5 L	977[13.6 Bl	965 11.2 Ht	999 9.6 Pt	001 9.4 Ah	007 9.3 BL
009 10.5 Jo	980 13.6 Dr	965 10.9 Bl	000 9.4 Ah	002 9.3 Ah	008 9.3 BL
R And	994 14.0 Dr	966 11.4 En	001 9.6 Ah	003 9.5 Ah	016 9.2 BL
001838	W Scl	971 11.4 Ht	002 9.8 Ah	004 9.4 Ah	019 9.1 BL
981 8.6 Ah	*002833*	974 11.6 Dr	003 9.8 Ah	006 9.8 Fd	022 9.1 BL
983 8.5 Ah	965 13.0 Bl	977 11.8 Bl	004 10.0 Ah	026 10.3 Fd	S Per
984 8.8 Ah	973[12.8 En	983 12.3 Dr	RU And	W And	021558
985 8.8 Ah	999 13.4 Dr	994 12.9 Dr	013238	021143a	984 9.5 Ah
989 8.8 Ah	Y Cep	005 13.5 Dr	981 12.4 Ch	999 13.0 Pt	996 9.4 Ah
990 8.8 Ah	003179	Z Cet	999 12.8 Pt	002 12.6 B	999 9.1 Pt
994 9.2 Ch	998[13.9 Br	*010102*	000 13.4 Lg	T Per	999 9.4 BL
996 9.1 Ah	U Cas	977 10.2 Ch	Y And	021258	000 9.3 BL
997 9.1 Ah	004047	982 10.2 L	013338	984 8.6 Ah	000 9.4 Ah
999 9.0 Pt	981[13.3 Ch	999 11.2 Pt	999 14.3 Pt	996 8.6 Ah	001 9.4 Ah
000 9.3 Ah	002 13.6 B	005 11.3 B	000 13.6 Lg	999 8.4 Pt	002 9.4 BL
001 9.2 Ah		007 11.4 L		999 8.4 BL	007 9.4 BL

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1930.

J.D.	Est.	Obs.
S PER		
021558		
008	9.4	BL
013	9.3	BL
016	9.3	BL
019	9.2	BL
022	9.4	BL
R CET		
022000		
980	10.8	Ch
990	9.3	L
996	8.5	Ch
996	8.9	Sf
002	8.5	Sf
007	8.3	L
008	8.5	Sf
022	8.5	Sf
RR PER		
022150		
999	13.0	Pt
002	13.4	B
R FOR		
022426		
953	9.8	Bl
965	8.7	Bl
977	9.0	Bl
U CET		
022813		
975	7.5	Ch
999	7.7	Pt
RR CEP		
022980		
973	11.0	Ch
988	11.7	L
998	12.5	Ch
999	11.9	Pt
R TRI		
023133		
978	6.5	Ch
981	6.6	Ah
983	6.6	Ah
984	6.5	Ah
985	6.6	Ah
987	6.4	Tf
989	6.7	Ah
990	6.7	Ah
991	6.8	Ah
991	6.6	Tf
993	6.8	Ah
994	6.8	Ah
996	6.8	Ah
997	6.8	Ah
999	7.5	Pt
000	6.8	Tf
000	6.9	Ah
001	6.9	Ah
001	6.7	Sf
002	7.0	Ah
003	7.1	Ah
004	7.0	Ah

J.D.	Est.	Obs.
R TRI		
023133		
007	6.9	Tf
022	7.6	Sf
W PER		
024356		
999	9.7	Pt
005	10.0	B
R HOR		
025050		
951	12.3	En
953	12.0	Bl
955	11.8	Ht
965	11.6	Ht
965	11.5	Bl
966	11.7	En
971	11.5	Ht
974	10.6	Dr
977	11.2	Bl
983	10.5	Dr
993	10.3	Dr
999	10.1	Dr
T HOR		
025751		
951	11.0	En
953	11.4	Bl
955	12.0	Ht
965	12.4	Bl
966	12.0	En
971	12.7	Ht
977	12.8	Bl
983	12.8	Dr
994	13.0	Dr
005	13.2	Dr
X CET		
031401		
978	9.2	Ch
990	9.9	L
993	10.1	Sf
999	9.9	Pt
002	10.4	Sf
007	11.3	L
Y PER		
032043		
982	9.0	Ch
999	8.5	Pt
999	8.6	BL
000	8.4	BL
002	8.2	BL
002	8.2	Lg
007	8.1	BL
008	8.0	BL
013	8.1	BL
016	8.1	BL
019	8.2	BL
022	8.0	BL
R PER		
032335		
982	10.2	Ch
999	8.5	Pt

J.D.	Est.	Obs.
R PER		
032335		
002	8.5	Lg
025	9.0	Mg
025	8.9	Sd
T FOR		
032528		
990	8.6	L
007	8.8	L
U ERI		
034625		
980	14.8	Dr
997	14.8	Dr
T ERI		
035124		
968	9.1	En
974	9.1	Dr
983	9.6	Dr
993	10.1	Dr
999	10.5	Dr
W ERI		
040725		
974	7.8	Dr
983	8.5	Dr
993	8.5	Dr
999	8.4	Dr
005	8.4	Dr
R TAU		
042209		
982	12.0	Ch
993	12.2	Dr
999	12.2	Pt
W TAU		
042215		
982	10.5	Ch
990	11.2	L
999	11.4	Pt
S TAU		
042309		
993[	13.3	Dr
T CAM		
043065		
973	11.9	Ch
988	12.4	L
999	13.0	Pt
002	12.6	BL
004	13.1	Br
RX TAU		
043208		
982	12.8	Ch
996	13.0	Br
999	13.3	Pt
007	13.5	L
R RET		
043263		
951[	12.4	En
965[	12.3	Ht
971[	12.3	Ht
977[	12.5	Bl
980	13.9	Dr

J.D.	Est.	Obs.
R RET		
043263		
997	13.3	Dr
X CAM		
043274		
988	8.2	L
994	8.9	Ch
999	9.7	Pt
004	10.4	Br
005	10.6	L
R DOR		
043562		
951	5.5	En
953	5.5	Bl
955	5.5	Ht
965	5.5	Ht
965	5.5	Bl
966	5.5	En
971	5.5	Ht
977	5.6	Bl
983	5.3	Dr
994	5.6	Dr
999	5.9	Dr
005	5.9	Dr
R CAE		
043738		
953	11.1	Bl
955	11.5	Ht
965	11.5	Ht
965	11.0	Bl
966	11.6	En
971	11.4	Ht
974	11.6	En
977	11.5	Bl
980	11.5	Dr
983	11.8	Dr
994	12.3	Dr
005	12.6	Dr
R PIC		
044349		
953	6.7	Bl
955	7.1	Ht
964	6.9	Ht
965	6.7	Bl
967	7.3	En
969	7.2	Ht
974	7.2	En
974	6.7	Dr
977	7.1	Bl
983	7.2	Dr
993	7.6	Dr
999	7.6	Dr
005	7.7	Dr
V TAU		
044617		
982	10.9	Ch
996	12.4	Br
999	12.0	Pt

J.D.	Est.	Obs.
R ORI		
045307		
982	10.1	Ch
990	9.8	L
999	10.9	B
007	10.9	L
024	10.5	Sd
024	10.8	Mg
R LEP		
045514		
972	7.8	Ch
987	6.0	Tf
990	6.9	L
996	7.0	Jo
999	6.4	Pt
000	7.0	Tf
003	6.6	Jo
006	7.8	Fd
007	7.1	L
007	6.5	Tf
009	7.0	Jo
016	7.3	Sb
021	8.5	Sb
025	8.9	Sb
026	7.3	Fd
V ORI		
050003		
990	9.8	L
996	9.4	Br
996	9.3	Ch
999	9.3	Pt
999	9.7	B
007	8.9	L
024	9.8	Sd
024	9.6	Mg
T LEP		
050022		
953	9.0	Bl
965	8.9	Bl
968	8.5	En
974	8.3	En
977	8.5	Bl
999	8.8	Pt
S PIC		
050848		
953	8.4	Bl
955	8.7	Ht
964	9.1	Ht
965	9.3	Bl
967	9.5	En
969	9.6	Ht
974	9.6	En
977	9.7	Bl
983	9.8	Dr
994	9.9	Dr
005	10.3	Dr
R AUR		
050953		
996	13.2	Ch

J.D.	Est.	Obs.
R AUR		
050953		
000	13.8	Pt
T PIC		
051247		
955	13.1	Ht
964	12.8	Ht
969	12.9	Ht
974	12.7	En
974	12.3	Dr
983	11.6	Dr
993	10.9	Dr
999	10.2	Dr
005	9.8	Dr
T COL		
051533		
953	8.8	Bl
955	9.0	Ht
965	10.0	Ht
965	9.6	Bl
967	9.7	En
971	10.2	Ht
974	10.3	En
974	10.2	Dr
977	10.3	Bl
983	10.8	Dr
994	11.2	Dr
001	11.7	Dr
024	11.9	Sd
025	11.9	Mg
S AUR		
052034		
973	9.2	Ch
999	9.2	BL
000	9.1	BL
000	8.3	Pt
002	9.1	BL
007	9.3	BL
008	9.2	BL
013	9.3	BL
019	9.3	BL
022	9.4	BL
W AUR		
052036		
973	11.7	Ch
988	12.3	L
996	12.5	Br
000	12.5	Pt
S ORI		
052404		
974	12.4	Ch
997	12.2	Ch
000	12.2	Pt
004	11.4	B
004	12.0	Br
025	11.6	Mg
025	11.4	Sd
T ORI		
053005a		
949	9.6	Be

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T ORI	RR TAU	S COL	U ORI	R MON	R GEM
053005a	053326	*054331*	054920a	063308	070122a
972 10.2 Ch	002 13.8 L	983 12.1 Dr	026 8.8 Fd	000 11.5 Pt	990 7.1 Ah
974 10.0 Be	005 13.7 L	994 12.7 Dr	V CAM	004 11.7 B	993 7.3 Ah
974 9.9 Gt	006[13.3 L	001 12.7 Dr	054974	NOV PIC	994 7.3 Ah
979 10.2 L	008 13.6 L	Z TAU	997 10.1 Br	*063462*	996 7.3 Ah
980 10.2 L	RU AUR	054615a	005[13.5 L	955 8.3 Ht	996 7.4 Jo
981 10.2 L	053337	996 13.5 Dr	Z AUR	964 8.1 Ht	997 7.3 Ah
990 10.1 L	996[13.4 Br	005 13.5 L	055353	966 8.2 En	997 7.5 Br
991 10.2 L	000[12.0 Pt	RU TAU	995 11.0 Pt	969 8.3 Ht	000 7.7 Wd
995 10.7 Pt	U AUR	054615c	996 11.0 Pt	972 8.2 En	000 7.0 Pt
996 10.7 Pt	053531	996 10.2 Br	996 10.7 Lg	S LYN	000 7.4 Ah
996 10.6 Lg	996 11.8 Br	996 10.9 Ch	999 10.3 Pt	063558	000 7.5 Jo
997 10.5 Ch	996 11.4 Ch	005 11.1 L	000 10.3 Pt	973 9.6 Ch	001 7.4 Ah
999 10.2 B	000 11.6 Pt	R COL	000 10.0 Lg	990 9.8 L	002 7.4 Ah
999 10.3 Pt	001 11.5 Ah	*054629*	001 10.1 Lg	993 9.8 Sf	003 7.4 Ah
000 10.4 Pt	005 10.7 L	953 9.6 Bl	001 10.2 Pt	996 9.8 Br	004 7.4 Ah
000 9.6 Lg	SU TAU	955 9.9 Ht	002 10.2 Lg	000 10.0 Pt	008 7.0 Al
000 10.1 L	054319	965 10.2 Ht	002 10.3 Pt	002 9.9 Sf	008 7.5 Wd
001 9.8 Lg	949 9.7 Be	965 9.8 Bl	005 10.5 Pt	006 10.3 L	009 7.7 Jo
001 10.6 Pt	976 9.8 Ch	967 10.2 En	006 10.3 Pt	X GEM	010 7.6 Wd
002 9.8 Lg	979 9.6 L	971 10.2 Ht	008 10.1 Al	064030	013 7.8 Wd
005 10.1 Pt	980 9.5 L	974 10.4 En	009 10.0 Pt	997 12.8 Br	016 7.8 Wd
006 10.4 Pt	981 9.5 L	974 9.8 Dr	011 9.9 Pt	997 13.2 Bn	020 7.8 Wd
006 10.1 L	982 9.6 L	977 10.3 Bl	015 10.0 Pt	004 12.4 B	022 7.8 Wd
007 11.0 L	988 9.5 L	994 10.8 Dr	016 10.0 Pt	013 12.2 Bn	Z GEM
009 10.5 Pt	991 9.5 L	005 11.5 Dr	018 10.0 Pt	022 11.5 Bn	070122b
011 10.4 Pt	993 9.5 Br	α ORI	019 10.0 Pt	Y MON	000 12.2 Pt
015 10.6 Pt	995 9.6 Pt	054907	R OCT	065111	TW GEM
016 10.2 Pt	996 9.6 Pt	998 0.3 L	*055686*	974 12.8 Ch	070122c
018 10.6 Pt	996 9.6 Br	U ORI	953 12.1 Bl	997 13.5 Br	000 8.3 Pt
019 10.5 Pt	997 9.6 Br	054920a	965 12.5 Bl	000 12.8 Pt	R CMI
AN ORI	997 9.8 Ch	981 7.9 Ah	974 12.6 Dr	004 13.8 B	070310
053005f	998 9.8 Br	983 8.0 Ah	977 12.6 Bl	006 13.8 L	974 10.0 Ch
979 11.7 L	999 9.6 Pt	984 8.0 Ah	996 13.0 Dr	X MON	991 10.0 L
981 11.6 L	000 9.6 Pt	985 8.0 Ah	X AUR	*065208*	R VOL
000 11.6 L	001 9.6 Pt	990 8.0 Ah	060450	987 7.8 Tf	*070772*
007 11.6 L	002 9.7 Pt	991 8.1 Ah	974 13.2 Ch	991 8.2 Tf	955 10.4 Ht
S CAM	004 9.7 Br	993 8.2 Ah	979 12.6 Lj	991 7.9 L	964 10.4 Ht
053068	005 9.5 L	994 8.2 Ah	987 13.2 L	000 8.5 Tf	968 10.8 En
999 8.7 BL	005 9.6 Pt	994 8.5 Ch	998 13.1 L	006 8.2 L	969 10.4 Ht
000 8.6 BL	006 9.6 Pt	996 8.3 Ah	000 12.6 Pt	007 9.4 Tf	974 10.6 En
000 8.2 Pt	007 9.6 L	996 8.5 Jo	002 12.4 Lj	R LYN	974 10.0 Dr
002 8.6 BL	009 9.7 Pt	997 8.4 Ah	003 12.4 Lj	065355	983 10.0 Dr
007 8.5 BL	011 9.6 Pt	999 8.6 B	008 12.2 Lj	990 11.6 L	994 10.0 Dr
008 8.5 BL	015 9.7 Pt	000 8.5 Ah	V AUR	997 12.1 Ch	005 10.2 Dr
013 8.3 BL	016 9.6 Pt	000 8.2 Pt	061647	997 11.8 Br	L_2 PUP
016 8.5 BL	018 9.6 Pt	001 8.6 Ah	974 12.6 Ch	V CMI	*071041*
019 8.5 BL	019 9.5 Pt	002 8.6 Ah	998 12.3 L	070109	974 3.7 Dr
022 8.3 BL	S COL	003 8.7 Ah	V MON	974 13.1 Ch	983 3.8 Dr
RR TAU	*054331*	003 8.7 Jo	*061702*	004 13.7 Br	993 4.2 Dr
053326	953 11.4 Bl	004 8.7 Ah	974 10.2 Ch	006 14.0 L	999 4.4 Dr
979 11.9 L	955 11.6 Ht	006 9.2 Fd	000 11.4 Pt	R GEM	005 4.7 Dr
980 11.9 L	965 11.9 Ht	008 8.0 Al	AG AUR	070122a	RR MON
981 12.7 L	965 11.8 Bl	009 8.7 Jo	062047	980 7.2 Ch	071201
982 13.4 L	967 11.6 En	009 8.6 Fd	987 9.9 L	981 7.2 Ah	974[13.4 Ch
988 13.0 L	971 12.0 Ht	010 9.0 Wd	998 9.8 L	983 7.3 Ah	V GEM
991 13.0 L	974 11.7 En	020 9.3 Wd	U LYN	984 7.2 Ah	071713
998 13.3 L	974 11.9 Dr	022 9.3 Wd	063159	985 7.2 Ah	974 12.0 Ch
000 13.6 L	977 12.1 Bl		996 11.3 Lg	989 7.2 Ah	000 12.9 Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1930.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

V GEM
071713
004 13.4 Br
004 13.8 B
006 13.5 L
S CMI
072708
974 9.2 Ch
997 10.5 Ch
000 10.2 Pt
000 9.7 Jo
006 10.5 Fd
009 10.6 Fd
009 9.9 Jo
013 11.0 BL
016 11.1 BL
T CMI
072811
974 11.5 Ch
000 12.3 Pt
002 11.7 Lg
006 13.0 L
S VOL
073173
953[13.2 Bl
964[13.2 Ht
968[12.2 En
974 13.4 Dr
996 12.8 Dr
005 12.2 Dr
U CMI
073508
974 9.3 Ch
991 10.4 L
000 11.0 Pt
002 11.2 Lg
S GEM
073723
974 12.0 Ch
997 9.6 Ch
999 9.7 B
000 9.5 Pt
004 9.6 Br
W PUP
074241
953 9.6 Bl
955 9.6 Ht
964 10.8 Ht
965 10.8 Bl
968 11.3 En
969 11.1 Ht
974 10.7 Dr
974 11.6 En
977 11.9 Bl
983 12.4 Dr
994 12.0 Dr
996 11.9 Dr
999 11.9 Dr
005 11.2 Dr

T GEM
074323
974 9.8 Ch
997 9.1 Ch
000 9.3 Pt
004 9.2 Dr
U PUP
075612
974[13.2 Ch
002[14.0 Lg
005[13.3 B
R CNC
081112
982 10.8 Ch
000 10.0 Pt
V CNC
081617
973 12.1 Ch
988 11.6 L
000 10.1 Pt
006 10.3 L
RT HYA
082405
000 7.5 Pt
R CHA
082476
053 7.7 Bl
955 7.8 Ht
964 7.2 Ht
965 7.4 Bl
968 7.8 En
969 7.4 Ht
974 8.0 En
977 7.8 Bl
U CNC
083019
981 12.0 Ch
988 11.5 L
006 11.4 L
X UMA
083350
000 9.9 Pt
S HYA
084803
978 8.2 Ch
983 8.2 Ah
984 8.4 Ah
985 8.2 Ah
990 8.0 Ah
991 8.0 Ah
994 7.8 Ah
996 7.7 Ah
997 7.6 Ah
000 7.5 Ah
000 7.5 Pt
001 7.5 Ah
002 7.5 Ah
003 7.5 Ah

T HYA
085008
981 11.5 Ch
990 11.3 L
006 9.9 L
T CNC
085120
973 9.2 Ch
000 8.4 Pt
T PYX
090031
939 [u3 Dr
977 [w Bl
996 [w Dr
997 14.7 Dr
001 14.8 Dr
V UMA
090151
987 10.8 L
003 10.8 L
W CNC
090425
981[12.8 Ch
003 14.0 L
RX UMA
090567
987 11.1 L
003 11.2 L
RW CAR
091868
953[12.8 Bl
964[12.8 Ht
971[12.8 En
997 14.8 Dr
Y VEL
092551
964[12.9 Ht
971[12.4 En
977 13.4 Bl
999 14.4 Dr
R CAR
092962
953 5.2 Bl
958 5.4 Ht
964 5.3 Ht
965 5.0 Bl
969 5.4 Ht
971 5.0 En
974 5.1 Dr
976 5.1 En
977 5.3 Bl
983 5.4 Dr
993 5.8 Dr
999 6.1 Dr
005 6.2 Dr
X HYA
093014
980 11.5 Ch

Y DRA
093178
995 12.8 L
R LMI
093934
981 12.8 Ch
000 12.8 Pt
006 12.2 Fd
RR HYA
094023
999 14.5 Dr
006 14.0 L
R LEO
094211
977 9.7 Ch
981 9.5 Ah
983 9.6 Ah
984 9.7 Ah
985 9.7 Ah
990 9.8 Ah
991 9.9 Ah
994 9.9 Ah
996 9.8 Ah
997 10.0 Ah
000 9.9 Ah
000 10.0 Pt
000 9.2 Tf
001 9.9 Ah
002 9.9 Ah
003 10.0 Ah
006 10.4 Fd
008 9.5 Tf
009 10.0 Fd
010 9.9 Wd
026 9.3 Fd
Y HYA
094622
998 6.4 Ch
000 6.3 Pt
Z VEL
094953
953 10.9 Bl
964 11.6 Ht
965 11.3 Bl
969 11.7 Ht
971 11.5 En
976 12.1 En
977 11.7 Bl
996 11.8 Dr
999 12.1 Dr
V LEO
095421
998 10.2 Ch
000 10.5 Pt
RR CAR
095458
964 8.3 Ht
969 8.2 Ht
972 8.1 En
976 8.1 En

RV CAR
095563
965[13.1 Ht
972[12.5 En
977[13.1 Bl
999 15.1 Dr
S CAR
100661
953 5.4 Bl
964 5.8 Ht
965 5.5 Bl
969 5.8 Ht
972 5.8 En
974 5.4 Dr
976 5.9 En
977 6.1 Bl
983 5.5 Dr
993 6.1 Dr
999 6.5 Dr
005 6.7 Dr
U UMA
100860
980 6.5 Ch
Z CAR
101058a
953 10.5 Bl
964 10.6 Ht
965 10.6 Bl
969 11.1 Ht
972 10.8 En
974 10.5 Dr
977 10.7 Bl
983 11.0 Dr
996 11.3 Dr
005 11.7 Dr
AF CAR
101058b
974 11.3 Dr
983 11.8 Dr
996 12.0 Dr
005 12.8 Dr
W VEL
101153
953 13.0 Bl
977 12.6 Bl
983 12.5 Dr
996 12.2 Dr
005 12.2 Dr
U HYA
103212
998 5.3 Ch
003 4.8 L
RZ CAR
103270
964 10.8 Ht
969 11.0 Ht
974 11.1 Dr
983 11.7 Dr
996 12.3 Dr
005 12.7 Dr

R UMA
103769
978 8.1 Ch
981 8.3 Ah
983 8.5 Ah
984 8.6 Ah
985 8.5 Ah
987 8.3 Tf
989 8.7 Ah
990 8.7 Ah
991 8.8 Ah
991 8.4 Tf
994 8.9 Ah
996 8.9 Ah
996 8.8 Jo
997 9.0 Ah
998 9.0 Ch
000 9.1 Pt
000 9.2 Ah
000 8.8 Tf
001 9.2 Ah
002 9.2 Ah
003 9.3 Ah
004 9.4 Ah
006 9.7 Fd
007 9.1 Tf
008 9.0 Jo
009 9.2 Jo
010 9.6 Wd
013 9.7 Wd
016 9.7 Wd
V HYA
104620
953 7.4 Bl
965 7.0 Bl
977 7.1 Bl
998 7.0 Ch
002 6.3 Pt
007 6.9 L
RS HYA
104628
953 13.2 Bl
977 12.8 Bl
W LEO
104814
003 14.0 L
RS CAR
110361
996[13.5 Dr
997[15.0 Dr
001[15.0 Dr
S LEO
110506
981 11.8 L
002 12.5 Pt
003 12.4 L
RY CAR
111561
965[13.1 Ht
974 13.7 Dr

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1930.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

RY CAR
111561
977[13.5 Bl
983 13.6 Dr
005 13.5 Dr
RS CEN
111661
953 12.7 Bl
965 12.5 Ht
971 11.6 Ht
974 11.4 Dr
977 11.2 Bl
983 10.3 Dr
994 9.4 Dr
996 9.2 Dr
999 9.2 Dr
005 8.6 Dr
X CEN
114441
953 9.5 Bl
965 9.6 Bl
971 10.5 Ht
974 9.8 Dr
977 10.7 Bl
983 11.0 Dr
999 11.7 Dr
AD CEN
114858
967 9.1 Ht
971 9.1 Ht
W CEN
115058
953 12.8 Bl
967 12.8 Ht
971 12.8 Ht
974 13.0 Dr
977 13.0 Bl
996 11.8 Dr
999 11.6 Dr
005 10.8 Dr
SU VIR
120012
002 11.4 Pt
T VIR
120005
990 10.4 L
002 10.2 Pt
005 10.7 L
R CRV
121418
988 7.8 L
002 9.1 Pt
005 8.6 L
SS VIR
122001
988 8.1 L
005 8.1 L
T CVN
122532
002 10.0 Pt

Y VIR
122803
988 12.3 L
005 13.3 L
U CEN
122854
977 13.0 Bl
000 12.2 Dr
001 12.3 Dr
T UMA
123160
002 13.0 Pt
009[11.5 Fd
026[12.1 Fd
R VIR
123307
998 7.4 Ch
002 7.6 Pt
RS UMA
123459
996 12.4 Bn
002 11.6 Pt
006 12.1 Fd
016 10.8 Bn
017 10.5 Bn
026 9.4 Fd
S UMA
123961
982 12.2 Lj
984 11.4 Ah
996 11.4 Ah
997 11.3 Ah
998 11.0 Ch
000 11.2 Ah
001 10.8 Ah
002 10.6 Ah
002 10.4 Pt
002 10.5 Lj
003 10.5 Lj
003 10.5 Ah
006 10.0 Fd
009 9.8 Fd
010 9.8 Wd
020 8.9 Wd
022 9.0 Wd
026 8.8 Fd
RU VIR
124204
988 9.0 L
002 9.6 Pt
005 9.4 L
U VIR
124606
991 9.4 L
002 9.9 Pt
005 10.7 L
RV VIR
130212
990 12.3 L
005 13.1 L

U OCT
131283
953 13.2 Bl
955 12.7 Ht
968[12.4 En
977 13.5 Bl
000 13.6 Dr
V VIR
132202
988 9.7 L
005 9.8 L
R HYA
132422
971 4.8 Ht
981 5.5 Ch
988 5.7 Ch
988 5.6 L
991 5.4 Tf
005 6.2 L
005 6.2 Pt
008 6.3 Tf
S VIR
132706
988 12.5 Ch
005 12.1 Pt
RV CEN
133155
953 8.4 Bl
965 8.3 Bl
971 9.5 Ht
977 8.6 Bl
T UMI
133273
005 14.2 L
009 11.4 Fd
T CEN
133633
971 6.2 Ht
974 6.4 Dr
996 7.8 Dr
001 8.5 Dr
005 8.8 Dr
RT CEN
134236
971 9.5 Ht
974 9.4 Dr
996 9.3 Dr
005 9.5 Dr
R CVN
134440
984 10.8 Ah
000 10.8 Ah
002 10.5 Ah
003 10.6 Ah
005 10.3 Pt
RX CEN
134536
971 12.1 Ht
974 11.5 Dr
996 10.0 Dr

RX CEN
134536
005 9.9 Dr
T APS
134677
953 9.7 Bl
965 9.8 Bl
965 10.0 Ht
971 10.3 Ht
974 10.3 Dr
977 10.6 Bl
996 11.7 Dr
RR VIR
135908
005 13.1 Pt
Z BOO
140113
991 13.2 L
005 13.7 L
Z VIR
140512
988 11.2 L
005 11.3 L
005 11.0 Pt
RU HYA
140528
971 10.7 Ht
974 10.1 Dr
001 11.6 Dr
R CEN
140959
953 6.7 Bl
965 6.8 Bl
971 7.0 Ht
974 7.3 Dr
977 7.2 Bl
996 7.6 Dr
001 7.7 Dr
U UMI
141567
979 12.2 Lj
982 12.5 Lj
984 11.6 Ah
003 12.2 Lj
005 11.9 Pt
S BOO
141954
993 8.4 L
004 8.2 Gb
005 8.0 Pt
006 7.9 L
RS VIR
142205
990 8.8 L
005 9.9 L
V BOO
142539a
984 8.0 Ah
990 7.9 Ah
991 8.0 Ah

V BOO
142539a
994 7.9 Ah
996 8.0 Ah
997 8.0 Ah
000 8.0 Ah
001 8.0 Ah
002 8.1 Ah
003 8.1 Ah
005 7.8 Pt
R BOO
143227
982 7.7 Lj
984 7.8 Ah
987 7.7 Lj
988 7.7 Lj
990 8.0 Ah
991 8.0 Ah
994 8.1 Ah
996 8.2 Ah
997 8.2 Ah
000 8.5 Ah
001 8.6 Ah
002 8.6 Ah
003 8.7 Lj
003 8.7 Ah
005 9.0 Pt
V LIB
143417
990 11.8 L
000 12.8 L
U BOO
144918
988 11.9 Ch
Y LUP
145254
965 11.1 Bl
974 11.5 Dr
977 11.2 Bl
996 12.7 Dr
S APS
145971
952 10.8 Bl
965 10.8 Bl
967 11.2 Ht
971 10.9 Ht
974 11.1 Dr
977 10.8 Bl
994 10.9 Dr
996 11.0 Dr
001 11.0 Dr
T LIB
150519
988[12.4 Ch
006[13.4 L
Y LIB
150605
003 13.2 L

S LIB
151520
988 13.0 L
003 13.5 L
S SER
151714
987 13.4 Ch
990 12.6 L
006 13.0 L
S CRB
151731
987 8.8 Ch
005 9.4 Pt
RS LIB
151822
988 10.4 L
006 8.9 L
RU LIB
152714
987 11.1 Ch
005 10.5 Pt
006 10.8 L
R NOR
152849
971 10.3 Ht
974 9.9 Dr
996 10.8 Dr
001 11.1 Dr
W LIB
153215
987[12.5 Ch
S UMI
153378
975 10.0 Ch
979 10.4 Lj
981 9.7 Ah
983 9.8 Ah
984 9.9 Ah
984 10.4 Lj
987 9.7 Ch
996 10.0 Ah
997 10.0 Ah
000 10.1 Ah
001 10.3 Ah
002 10.4 Ah
002 10.5 Lj
003 10.6 Jo
003 10.4 Ah
005 10.2 Pt
009 10.3 Jo
T NOR
153654
971 10.3 Ht
974 9.8 Dr
001 11.9 Dr
R CRB
154428
976 6.1 Ch
979 6.0 L
980 6.0 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R CrB	RR Lib	SS Her	S Oct	RY Oph	R Aql
154428	*155018*	162807	*172486*	181103	190108
981 6.0 L	990 12.1 L	005 8.8 L	953 9.6 Bl	018 12.0 Pt	018 6.0 Pt
982 6.2 Lj	005 11.0 Pt	005 9.2 Pt	955 9.1 Ht	W Lyr	X Lyr
983 6.1 Ch	006 10.9 L	T Oph	964 8.7 Ht	181136	190926
984 6.3 Ah	Z CrB	*162815*	965 8.9 Bl	987 8.0 L	018 8.7 Pt
986 6.0 L	155229	005 13.7 L	968 8.0 En	006 10.1 L	RS Lyr
987 6.0 L	987 11.8 Ch	S Oph	969 8.6 Ht	018 9.4 Pt	190933a
987 6.2 Lj	990 11.2 L	*162816*	974 8.5 Dr	RV Sgr	980[13.4 L
987 6.1 Ch	006 12.1 L	005 14.2 L	977 8.8 Bl	*182133*	007 12.7 L
988 6.1 Ch	RZ Sco	W Her	993 8.5 Dr	952[11.9 Bl	RU Lyr
988 6.1 Lj	*155823*	163137	999 8.8 Dr	SV Her	190941
990 6.0 L	005 9.6 Pt	987 9.3 Ch	RU Oph	182224	980 11.6 L
991 6.0 L	Z Sco	005 8.6 Pt	172809	005 12.1 L	007 11.9 L
991 5.9 Tf	*160021*	R Dra	006 12.9 L	SV Dra	U Dra
992 6.0 L	988 11.2 L	163266	RT Ser	183149	190967
993 6.0 L	006 11.6 L	982 12.4 Lj	*173411*	991 13.0 L	949 9.3 Be
995 6.0 L	R Her	987 12.2 Ch	006 12.4 L	006 12.6 L	961 10.0 Be
996 6.3 Ah	160118	996 10.3 Jo	RU Sco	RZ Her	990 10.8 L
997 6.1 Ah	005 9.5 Pt	000 9.9 Jo	*173543*	183225	007 11.5 L
998 6.0 L	SX Her	001 11.3 Ah	952 9.6 Bl	006 12.4 L	RY Sgr
999 6.2 Pt	160325	002 10.8 Ah	W Pav	X Oph	*191033*
000 6.2 Ah	988 7.9 L	003 10.8 Ah	*174162*	183308	953 6.0 Bl
001 6.2 Ah	002 7.9 Pt	003 11.1 Lj	953 8.5 Bl	979 8.8 L	S Sgr
001 6.2 Pt	003 7.8 L	006 11.2 Fd	965 9.1 Bl	993 8.8 L	*191319a*
002 6.2 Pt	005 7.9 Pt	009 9.8 Jo	977 9.0 Bl	007 8.7 L	953 9.9 Bl
002 6.2 Ah	006 8.0 Pt	009 10.8 Pt	001 10.6 Dr	018 8.5 Pt	SW Sgr
003 6.2 Ah	009 8.0 Pt	026 9.3 Fd	RT Oph	RY Lyr	*191331*
003 5.9 Lj	018 8.0 Pt	S Dra	175111	184134	953 11.6 Bl
003 5.9 L	RU Her	164055	990 10.2 L	006[13.4 L	TZ Cyg
004 6.0 L	160625a	949 9.0 Be	007 9.5 L	R Sct	191350
005 6.0 L	987 10.7 Ch	961 8.6 Be	RY Her	*184205*	018 10.0 Pt
005 6.1 Pt	988 10.2 L	RR Oph	175519	987 6.0 L	AF Cyg
006 6.0 L	003 11.0 L	*164319*	979 10.2 L	990 6.5 L	192745
006 6.1 Pt	005 10.4 Pt	990 10.4 L	005 11.6 L	991 6.5 Tf	981 7.3 Ah
007 6.0 L	S Sco	007 11.2 L	018 12.0 Pt	993 6.5 L	983 7.2 Ah
008 5.8 Tf	*161122b*	009 11.8 Pt	V Dra	003 6.9 Lj	984 7.3 Ah
009 6.2 Pt	005 12.5 Pt	S Her	175654	005 6.3 L	985 7.3 Ah
018 6.1 Pt	W CrB	164715	979 13.4 L	008 6.6 Tf	987 7.5 Ah
X CrB	161138	009 11.9 Pt	005 12.3 L	RX Lyr	989 7.3 Ah
154536	005 12.1 Pt	RS Sco	R Pav	185032	990 7.2 Ah
998 13.4 L	W Oph	*164844*	*180363*	980 12.0 L	993 7.3 Ah
005 13.3 Pt	*161607*	001 11.7 Dr	955 10.8 Ht	005 12.7 L	996 7.4 Ah
006 12.8 L	005[13.7 L	RV Her	T Her	S CrA	997 7.2 Ah
R Ser	V Oph	165631	180531	*185437a*	000 7.3 Ah
154615	*162112*	993 14.0 L	979 8.5 L	953 11.6 Bl	001 7.3 Ah
987 7.1 Ch	990 7.2 L	006 13.5 L	004 7.1 L	R CrA	002 7.4 Ah
005 7.8 Pt	005 7.2 L	— Dra	008 7.2 Tf	*185537a*	003 7.3 Ah
V CrB	005 7.1 Pt	165752	018 7.7 Pt	953[12.5 Bl	004 7.3 Ah
154639	008 7.9 Tf	993 12.9 L	W Dra	T CrA	R Cyg
987 8.9 Ch	U Her	RT Her	180865	*185537b*	193449
005 8.4 Pt	162119	170627	005[12.9 L	953[12.5 Bl	975[11.3 Ch
R Lib	987 8.6 Ch	993 10.3 L	X Dra	Z Lyr	995 13.5 Pt
154715	005 9.1 Pt	009 10.0 Pt	180666	185634	006[11.3 Fd
987 12.6 Ch	Y Sco	Z Oph	005[13.5 L	980 12.5 L	RV Aql
006 14.0 L	*162319*	171401	TV Her	007[14.0 L	193509
R Lup	006[13.5 L	009 12.0 Pt	181031	RT Lyr	006 8.8 L
154736	SS Her	RS Her	005[14.0 L	185737	T Pav
001 10.1 Dr	162807	171723		980 10.6 L	*193972*
	990 8.8 L	009 9.0 Pt		006 10.0 L	953 11.4 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T PAV	S TEL	WX CYG	RZ CYG	RR AQR	R GRU
193972	*195855*	201437b	204846	210903	*214247*
955 11.3 Ht	953 13.1 Bl	007 11.4 L	995 11.5 Pt	991[11.0 L	966 12.9 En
965 9.5 Ht	965 13.2 Bl	U CYG	S IND	Y PAV	969 12.5 Ht
965 10.2 Bl	969 12.6 Ht	201647	*204954*	211570	976 12.9 En
971 9.3 Ht	SY AQL	974 8.4 Ch	955[13.1 Ht	955 5.6 Ht	977 12.2 Bl
974 9.0 Dr	200212	995 8.5 Pt	965[13.5 Bl	965 5.8 Ht	V PEG
977 9.4 Bl	990 9.8 L	996 8.6 Jo	971[13.1 Ht	971 6.1 Ht	215605
993 8.7 Dr	007 10.3 L	000 8.8 Jo	X DEL	X PEG	007 12.7 L
999 8.8 Dr	BU CYG	006 9.3 Fd	205017	211614	RT PEG
005 9.1 Dr	200250	009 9.0 Jo	995 13.5 Pt	980 9.5 L	215934
RT CYG	979 10.7 Lj	U MIC	T OCT	998 9.5 L	982 10.0 L
194048	984 10.4 Lj	*202240*	*205782*	999 10.8 Pt	990 10.0 L
975 7.8 Ch	991 10.5 Lj	953 13.3 Bl	974 9.8 Dr	S MIC	000 10.3 L
981 8.1 Ah	003 10.8 Lj	965[13.0 Bl	983 10.1 Dr	*212030*	RZ PEG
983 8.2 Ah	S CYG	RW CYG	999 12.4 Dr	950[11.6 En	220133b
984 8.4 Ah	200357	202539	005 12.0 Dr	953[13.4 Bl	982 9.2 L
985 8.4 Ah	975 11.6 Ch	949 9.3 Be	R VUL	966[12.4 En	986 9.0 B
987 8.5 Ah	990 11.7 L	ST CYG	205923a	W CYG	999 9.4 Pt
989 8.5 Ah	995 11.6 Pt	202954	995 12.7 Pt	213244	000 9.1 L
990 8.5 Ah	998 11.3 Br	980 14.2 L	V CAP	981 5.7 L	T PEG
993 8.6 Ah	007 10.9 L	995 14.0 Pt	*210124*	990 5.9 L	220412
995 8.7 Pt	S AQL	V VUL	965[11.5 Bl	991 6.0 Tf	998 12.1 L
996 8.7 Jo	200715a	203226	X CAP	998 6.0 Tf	RS PEG
996 8.7 Ah	976 9.3 Ch	995 8.7 Pt	*210221*	998 5.8 L	220714
997 8.7 Ah	R TEL	R MIC	953[12.4 Bl	007 5.7 L	998 13.4 L
000 8.8 Ah	*200747*	*203420*	X CEP	S CEP	T GRU
001 8.8 Ah	953 11.6 Bl	953 10.8 Bl	210382	213678	*221938*
002 8.9 Ah	965 11.7 Bl	965 9.8 Bl	998[13.9 Br	998 11.4 Br	950 9.2 En
003 9.0 Ah	977 11.6 Bl	977 8.8 Bl	R EQU	999 10.4 Pt	966 8.4 En
003 9.0 Jo	RU AQL	S DEL	210812	RU CYG	976 8.4 En
004 9.0 Ah	200812	203816	990 10.6 L	213753	S GRU
006 9.0 Fd	990 8.9 L	979 10.6 Lj	995 10.4 Pt	981 7.9 Ah	*221948*
009 9.2 Jo	007 9.5 L	984 10.8 Lj	T CEP	983 7.8 Ah	950[12.8 En
TU CYG	W CAP	991 10.7 Lj	210868	984 7.8 Ah	963[12.8 Ht
194348	*200822*	995 11.2 Pt	973 6.7 Ch	985 7.9 Ah	969[12.8 Ht
975[11.3 Ch	953 11.5 Bl	003 10.7 Lj	980 6.9 Ch	987 7.9 Ah	RV PEG
990[12.2 L	RS CYG	V CYG	981 6.7 Ah	989 7.9 Ah	*222129*
X CYG	200938	203847	983 6.7 Ah	990 7.8 Ah	991 10.9 L
194632	975 6.8 Ch	974 11.8 Ch	984 6.7 Ah	993 7.9 Ah	007 10.8 L
974 12.0 Ch	990 7.5 L	980 12.2 L	985 6.7 Ah	996 7.9 Ah	S LAC
995 12.6 Pt	995 7.0 Pt	995 12.5 Pt	989 6.8 Ah	997 7.9 Ah	*222439*
RU SGR	996 7.2 Jo	007 12.5 L	990 6.8 Ah	999 7.5 Pt	998 13.5 L
195142	000 7.4 Jo	Y AQR	991 6.8 Ah	000 8.0 Ah	999 13.3 Pt
953 13.4 Bl	007 7.5 L	*203905*	994 7.0 Ah	001 8.0 Ah	002 13.0 B
965 12.8 Bl	009 7.4 Jo	976[10.1 Ch	996 7.0 Ah	002 8.0 Ah	R IND
NOV CYG	SX CYG	T DEL	996 7.0 Jo	003 8.0 Ah	*222867*
195553	201130	204016	997 7.0 Ah	004 8.0 Ah	953 12.9 Bl
995[12.2 Pt	990 9.7 L	991[12.2 L	999 7.0 Pt	RV CYG	955 12.2 Ht
005[12.2 Pt	995 9.7 Pt	995 12.1 Pt	000 7.1 Jo	213937	965 12.2 Ht
018[12.2 Pt	008 9.3 L	V AQR	000 7.3 Ah	999 6.1 Pt	965 12.1 Bl
RR TEL	RT SGR	204102	001 7.1 Ah	RR PEG	971 11.8 Ht
195656	*201139*	990 8.9 L	002 7.3 Ah	214024	974 11.6 Dr
955[12.6 Ht	953 8.9 Bl	U CAP	003 7.5 Ah	999 10.0 Pt	977 11.1 Bl
963[12.6 Ht	965 9.9 Bl	*204215*	004 7.4 Ah	R GRU	983 10.5 Dr
969[12.6 Ht	977 10.4 Bl	953 11.8 Bl	006 7.7 Fd	*214247*	993 9.7 Dr
Z CYG	WX CYG	T AQR	009 7.3 Jo	953 13.1 Bl	999 9.7 Dr
195849	201437b	*204405*	016 7.8 Sb	955 12.6 Ht	005 9.2 Dr
980 13.9 L	990 11.6 L	976 9.0 Ch	022 6.5 Sb	963 12.4 Ht	
995 12.7 Pt	995 11.0 Pt			965 12.7 Bl	

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1930.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
T TUC			**V CAS**			**V PHE**			**R AQR**			**RR CAS**			**R TUC**		
223462			230759			*232746*			*233815*			235053			*235265*		
950	9.0	En	994	9.9	Ch	971	11.6	Ht	955	8.6	Ht	990	6.2	Ah	966	12.0	En
955	9.5	Ht	999	9.2	Pt	974	12.2	Dr	963	8.6	Ht	991	6.2	Ah	971	12.4	Ht
965	10.2	Ht	999	9.3	B	976	12.3	En	965	8.9	Bl	994	6.3	Ah	974	11.2	Dr
966	9.9	En	016	8.8	Sf	993	13.0	Dr	966	8.6	En	994	6.0	Ch	983	10.1	Dr
971	10.7	Ht	022	8.5	Sf	999	13.2	Dr	969	8.4	Ht	996	6.3	Ah	993	9.6	Dr
974	10.6	Dr	**W PEG**			**Z AND**			**977**	9.0	Bl	997	6.5	Ah	999	9.9	Dr
983	10.8	Dr	231425			232848			980	8.9	L	000	6.4	Ah	**R CAS**		
993	11.7	Dr	981	12.6	Ch	971	10.3	Md	990	8.8	L	001	6.5	Ah	235350		
999	12.2	Dr	991	12.4	L	996	9.9	Lg	994	8.6	Ch	002	6.4	Ah	005	6.8	B
R LAC			008	12.8	L	999	10.4	Pt	998	8.7	Tf	003	6.5	Ah	**Z PEG**		
223841			**S PEG**			**ST AND**			999	8.6	Pt	004	6.6	Ah	235525		
976	10.6	Ch	231508			233335			008	8.9	L	013	[11.7	Bn	979	12.9	Lj
990	11.6	L	981	12.4	Ch	973	10.8	Ch	**Z CAS**			**R PHE**			**981**	**12.8**	**Ch**
999	12.3	Pt	991	12.5	L	979	10.8	Lj	233956			*235150*			991	13.2	L
008	12.6	L	999	11.6	Pt	984	10.8	Lj	980	10.8	Ch	971	10.7	En	999	12.5	Pt
S AQR			002	11.6	B	991	**10.8**	**Lj**	990	10.6	L	974	10.6	Dr	003	12.7	Lj
225120			008	11.4	L	999	10.7	Pt	999	10.6	B	976	10.4	En	007	12.5	L
972	[12.5	En	**RY CEP**			999	10.3	B	007	10.5	L	983	10.2	Dr	008	12.6	Lj
RW PEG			231878			002	10.8	Lj	**RR CAS**			993	9.0	Dr	**Y CAS**		
225914			973	9.4	Ch	003	10.8	Lj	235053			999	8.6	Dr	235855		
981	13.1	Ch	**V PHE**			008	10.4	Lj	981	6.1	Ah	**V CET**			980	10.4	Ch
002	[13.2	B	*232746*			**R AQR**			983	6.2	Ah	235209			990	10.0	L
008	14.0	L	**955**	**10.4**	**Ht**	*233815*			984	6.1	Ah	990	11.7	L	999	10.1	B
R PEG			965	11.3	Ht	950	8.6	En	985	6.0	Ah	008	9.4	L	007	10.3	L
230110			966	11.4	En	953	8.9	Bl	989	6.2	Ah	**R TUC**			**SV AND**		
981	12.4	Ch										*235265*			235939		
999	9.2	Pt										965	12.6	Ht	999	14.0	Pt
															002	13.0	B

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.	Obs	J.D.	Est.	Obs.	Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
005840	RX ANDROMEDAE—						074922	U GEMINORUM—					
	5971.5	[10.4	Ch	5999.6	13.2	Pt		5974.2	13.9	Ch	5998.6	9.3	L
	5993.6	12.0	Br	6000.6	[12.4	Pt		5977.1	[12.3	Ch	5998.7	9.6	Br
	5994.6	12.9	Br	6001.6	[11.3	Pt		5979.3	13.9	L	5999.6	9.3	Pt
	5995.5	13.2	Pt	6004.6	11.0	Br		5979.7	14.1	L	6000.2	9.3	L
	5996.6	13.6	Br	6005.5	10.9	Pt		5980.3	14.1	L	6000.6	9.2	Pt
	5997.6	13.2	Br	6006.5	11.0	Pt		5980.7	[13.1	L	6000.6	9.4	Lg
	5998.7	13.5	Br					5981.2	14.1	Ch	6001.5	9.2	Pt
060547	SS AURIGAE—							5981.3	14.0	L	6002.3	9.5	L
	5949.3	[13.0	Be	5997.6	14.4	Br		5982.3	[13.7	L	6002.6	8.9	Lg
	5974.1	10.8	Ch	5998.3	14.1	L		5987.4	[13.3	Ch	6003.6	9.4	L
	5974.2	10.9	Be	5999.6	[12.6	Pt		5988.6	14.0	L	6004.6	10.0	B
	5974.2	10.9	Gt	6000.3	14.4	L		5990.4	[12.9	L	6004.7	10.4	Br
	5977.1	11.2	Ch	6001.5	[12.0	Pt		5990.7	[12.4	L	6005.6	10.2	L
	5979.3	12.4	L	6002.6	[14.0	Lg		5991.7	[10.0	L	6005.6	10.9	B
	5979.7	13.0	L	6003.6	[13.0	L		5992.3	[12.4	L	6006.5	11.2	Pt
	5980.3	13.5	L	6004.6	[13.9	Br		5993.7	[12.4	L	6006.6	11.4	L
	5981.3	13.5	L	6005.5	[12.6	Pt		5995.5	9.1	Pt	6007.4	11.5	L
	5981.7	13.8	L	6006.6	[14.5	L		5995.6	9.0	L	6007.7	12.0	L
	5982.2	[13.0	Ch	6007.4	15.0	L		5996.1	9.3	Ch	6008.7	**12.8**	**L**
	5982.3	13.9	L	6009.9	[12.6	Pt		5996.6	9.1	Lg	6009.9	[12.4	Pt
	5987.7	[13.8	L	6011.6	[11.5	Pt		5997.7	9.4	Br	6011.6	[12.0	Pt
	5990.6	[12.4	L	6015.7	[12.0	Pt		5998.3	9.4	L	6015.7	[11.7	Pt
	5991.4	[12.4	L	6016.7	[11.0	Pt	081473	Z CAMELOPARDALIS—					
	5993.6	[13.9	Br	6018.7	[12.0	Pt		5979.3	12.6	L	5981.3	12.9	L
	5995.5	[12.6	Pt	6019.5	[12.4	Pt		5979.7	12.4	L	5982.3	12.6	L
	5996.6	14.4	Br					5980.3	12.7	L	5987.7	**12.5**	**L**

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
081473 Z CAMELOPARDALIS—						
	5988.7	12.9	L	6000.3	12.2	L
	5990.4	12.6	L	6002.3	12.8	L
	5991.3	11.4	L	6003.6	12.2	L
	5991.7	10.9	L	6004.7	12.3	Br
	5993.7	10.8	L	6005.6	11.6	L
	5995.6	11.4	L	6006.6	10.8	L
	5997.7	11.6	Br	6007.4	10.9	L
	5998.3	11.9	L	6007.7	11.0	L
094512 X LEONIS—						
	5979.4	12.1	L	6000.3[	13.8	L
	5979.7	12.0	L	6003.6[	14.2	L
	5980.4	12.1	L	6005.6[	14.2	L
	5980.7	12.1	L	6006.6	13.5	L
	5981.7	12.0	L	6007.4	12.2	L
	5987.7[	14.7	L	6007.7	12.2	L
	5998.6[	13.8	L			
202946 SZ CYGNI—						
	5995.5	9.5	Pt	6005.5	9.0	Pt
	5996.5	9.4	Pt	6006.5	9.0	Pt
	5999.6	9.1	Pt	6016.7	9.6	Pt
	6000.6	9.4	Pt	6018.6	9.5	Pt
	6001.5	9.6	Pt	6019.5	9.2	Pt
213843 SS CYGNI—						
	5961.2	11.6	Be	5974.2	8.2	Gt
	5971.4	11.5	Md	5977.1	8.5	Ch
	5973.1	8.9	Ch	5979.2	8.3	Lj
	5974.2	8.2	Be	5979.3	8.7	L

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—						
	5980.2	8.4	Lj	5997.2	11.6	Ah
	5980.3	8.6	L	5997.6	11.2	Br
	5981.2	8.5	Ah	5998.3	11.4	L
	5981.3	8.7	L	5998.6	11.5	Br
	5982.3	8.7	L	5999.5	11.5	B
	5983.1	8.8	Ch	5999.6	11.5	Pt
	5983.2	8.8	Ah	6000.2	11.6	L
	5984.2	9.1	Ah	6000.2	11.8	Ah
	5984.2	8.8	Lj	6000.6	12.0	Jo
	5985.2	9.4	Ah	6000.6	11.6	Pt
	5986.5	9.9	B	6001.2	11.8	Ah
	5987.3	10.3	Ah	6001.5	11.7	Pt
	5989.2	10.6	Ah	6002.2	11.6	Ah
	5990.3	11.4	L	6002.5	11.6	B
	5990.3	10.9	Ah	6003.2	11.4	Ah
	5991.2	11.8	Lj	6003.2	11.9	Lj
	5991.2	11.5	L	6003.6	12.0	Jo
	5993.2	11.6	Ah	6004.2	11.4	Ah
	5993.6	11.6	Br	6004.6	11.4	Br
	5994.6	11.6	Br	6005.5	11.5	Pt
	5994.6	11.7	Sd	6006.5	11.6	Pt
	5994.6	11.7	Mg	6006.5	11.9	Fd
	5995.5	11.7	Pt	6007.2	11.7	L
	5996.0	11.8	Ch	6008.2	12.0	Lj
	5996.3	11.7	Ah	6008.3	12.0	L
	5996.5	11.7	Pt	6009.6	11.8	Jo
	5996.6	11.8	Jo	6016.7	11.7	Pt
	5996.6	11.6	Br	6019.5	9.0	Pt

MONTHLY SUMMARY FOR FEBRUARY, 1930.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	28	300	Houghton	Ht	58	128
Allen, P. R.	Al	3	3	Jones	Jo	14	38
Baldwin	Bl	72	150	Lacchini	L	155	358
Benini	Be	9	15	Leiner	Lj	14	49
Boutell	BL	9	64	Logan	Lg	15	23
Bouton	B	37	40	Millard	Md	4	4
Brocchi	Br	34	54	Monnig	Mg	6	6
Brown, A. N.	Bn	4	10	Peltier	Pt	170	249
Chandra	Ch	131	159	Sanders	Sd	6	6
Dartayet	Dr	70	216	Smith, F. W.	Sf	6	14
Ensor	En	48	79	Soberanes	Sb	2	5
Ford	Fd	19	31	Taffara	Tf	15	34
Gaebler	Gb	1	1	Webb	Wd	5	17
Gallanti	Gt	3	3				
				Totals	27	388	2056

ary. The maximum was of the long, broad type, and the interval between this maximum and the one previously observed was 234 days. If the slow, narrow maximum which usually occurs between two long, broad maxima made its appearance, it must have happened prior to October, 1929, for since that time the observations have been too numerous and continuous to have allowed a maximum to have escaped attention. SS Cygni, according to observations by Mr. Peltier, was near maximum again on February 11. Since this is the time of the year when SS Cygni is rather poorly placed for observation, it is to be hoped that

observers in all longitudes have made an extra effort to observe this maximum in order that full information as to its type, etc., may have been obtained.

LEON CAMPBELL, Recording Secretary.

March 11, 1930.

COMET NOTES

By G. VAN BIESBROECK.

Two new comets have been announced this month. They will receive the temporary designation of 1930 *b* and 1930 *c*.

BEYER COMET (1930 *b*). This object was found by M. Beyer at Hamburg on March 11. The circumstances of the discovery are not yet available. Max Beyer is known as a variable star observer and it is probable that, in the course of his visual observations, he noticed the object; but it is remarkable that at the time of discovery it was situated within 45° of the moon, which was then only two days before the full phase! The first telegram, circulated on March 13, at the same time as the announcement of the discovery of a transneptunian planet by the Lowell observers was as follows:

1930 March 11.8545 U.T. $6^h\,5^m\,20^s$ $+32°\,22'$ Mag. 10.

The object was slowly moving northward and soon was observed at various stations. Its trace was also found on plates taken at the Berlin Observatory earlier in March and even in January and February so that very quickly an orbit could be computed. On March 17 the following elements and ephemeris were sent out by A. O. Leuschner of the Berkeley Astronomical Department:

Elements of Beyer Comet by C. Bower and Miss Moore from observations on January 23 and February 18 (Berlin) and March 14 (Yerkes):

T = 1930 April 21.64 U.T.
ω = 26° 27′
Ω = 116 33
i = 71 17
q = 2.051 astr. units
e = 0.9724
Per. = 639.96 years

EPHEMERIS.

0^h U.T.		α h	m	s	δ °	′
1930 March	21	6	6	0	+36	15
	25		7	20	37	46
	29		9	20	39	12
April	2	6	12	0	+40	33

While the orbit is well determined by three observations so well spaced, it will need some revision on account of the fact that there was an error of 1′ in the declination as given out by the writer for March 14. However, this will not affect the general nature of the comet's course. Its orbit is nearly parabolic and highly inclined but the minimum distance to the sun, which is reached in April, is large so that the comet stays outside of the orbit of Mars. It will be visible for several months but without getting brighter than it is at present. Its magnitude is estimated either 10th or 11th which places it in reach of moderate sized instruments. As observed by the writer during its first week of visibility the object appeared

as a round coma about 2′ in diameter with a sharp central condensation.

How closely L. C. Peltier at Delphos (Ohio), discoverer of the first comet of this year, watches the sky is shown by the fact that he picked up Beyers' Comet independently on March 21. He wired the writer about his finding, evidently having missed the notices in the daily papers about Beyer's Comet. Apparently it is easier for Mr. Peltier to find a comet in the sky than in the newspapers!

The following observations of the comet are known at present:

1930	α h m s	δ ° ′ ″		Observer
Jan. 23.9340 U.T.	6 55 46.3	+ 3 43 9	..	Prager (Berlin)
Feb. 18.1235	18 23.79	20 45 3.8	11	Prager (Berlin)
Mar. 2.9160	8 12.9	28 3 5	..	Prager (Berlin)
3.8826	7 40.5	28 32 2	..	Prager (Berlin)
14.17788	5 10.02	33 24 13.7	10	Van Biesbroeck
15.08951	5 10.00	33 47 48.8	11	Van Biesbroeck
16.11858	5 11.52	34 12 59.1	11	Van Biesbroeck
17.04884	5 15.66	34 37 26.8	10	Van Biesbroeck
19.0374	5 31.1	35 26 11	..	Castro (Cordoba)
19.10676	5 32.13	35 27 43.8	10	Van Biesbroeck
20.10156	5 43.63	35 51 34.9	10	Van Biesbroeck
21.18813	5 59.04	36 17 7.5	10	Van Biesbroeck

Comet Wilk (1930*c*). This bright comet, the third announced this year, was picked up by A. Wilk at Cracow (Poland) who has already two earlier cometary discoveries to his credit. The discovery reads:

"Banachiewicz (Cracow) announces: Wilk comet. Magnitude 7.
March 21.7764 U.T. $1^h 27^m$ +18° 3′ (1855).

Two further positions have been communicated telegraphically: 1930 Mar. 22.8241 $1^h 29^m 21^s.2$ +19° 55′ 11″ 6^M G. Struve (Berlin); Mar. 23.7967 $1^h 27^m 37^s.1$ +21° 18′ 20″ 6^M Vinter-Hansen and Möller (Copenhagen), showing that the comet moves northwestward and is about visible to the naked eye just after sunset. Cloudy weather has prevented observations at Williams Bay.

Wilk's Comet was found within 20° of the place where Daniel's Comet (1909 IV) is located according to the prediction by F. R. Cripps (p. 174). But the motion does not correspond so that the return of the comet of 1909 is still to be awaited.

Elements of Wilk's Comet (1930*c*) by Whipple and Miss Hayford from observations on March 22, 23, and 25.

T = 1930 March 28.83 U.T.
ω = 47° 54′ }
Ω = 90 3 } 1930
i = 64 27 }
q = 0.477 astr. units

Ephemeris.

0h U.T.	α h m s	δ ° ′	H
1930 Mar. 29	1 14 21	+28 19	1.00
April 2	0 59 40	32 54	
6	41 45	36 37	
10	0 21 39	+39 25	0.85

Peltier-Schwassmann-Wachmann Comet (1930*a*). From available information it now appears that this comet was found independently by the two German astronomers at Hamburg who were also the codiscoverers of comets

1925 *i* and 1929 *a*. In this case their announcement reached the Central Bureau at Copenhagen two hours after arrival of the cablegram giving the first position of Peltier's object.

The comet has followed the prediction given on p. 173 quite closely both in regard to position and to brightness. On March 5 it was seen last with the 40-inch refractor: it had then a faint nucleus (15^M) some 5″ in diameter surrounded by a hardly perceptible coma of 40″ in diameter. On March 8 the object was no longer visible, but it was photographed yet on March 19 with the 24-inch reflector as a very faint nebulosity of magnitude 16. The comet will therefore have been followed for only a month.

F. E. Seagrave sends the following orbit for WILK'S COMET 1929 *d*, based on three positions, Dec. 22, 1929, Jan. 8, and 29, 1930, covering an interval of 38 days:

$$\begin{aligned} T &= \text{Jan. } 22.3246 \text{ U.T.} \\ \omega &= 157^\circ\ 28'\ 11\overset{''}{.}2 \\ \Omega &= 178\ \ 59\ \ 10.4 \\ i &= 124\ \ 31\ \ 32.9 \\ \log a &= 2.8668766 \\ \log e &= 9.9996041 \\ \log q &= 9.8264908 \end{aligned}$$

The computation has been done carefully but the deviation from the parabola is very slight and the value of the major-axis is therefore quite uncertain. A discussion of all the observational material, taking perturbations into account, would be required in order to find the limits of uncertainty of this quantity. But there is no question that the period runs into many centuries.

In No. 39 of the *Tokyo Astronomical Bulletins* (1930 Feb. 10) S. Kanda gives a rediscussion of the orbit of PERIODIC COMET WOLF (1924 *d*), the faint object that was followed from 1924 Dec. 23 to 1925 Jan. 23. The period is 7.488 years and at aphelion the comet is very near to the orbit of Jupiter. The next perihelion passage will occur in June, 1932, but the conditions of observation are unfavorable. In 1936 there will be a close approach of Jupiter. Previous computations had given December 30, 1924, for the date of perihelion passage and hence the comet had been called 1924 IV. The new computation requires the designation 1925 I, with the result that the numbers assigned to the eleven other comets, having their perihelion passage in 1925, will have to be increased by one unit.

S. Kanda has also computed new elements for COMET SCHWASSMANN-WACHMANN (1929 *a*) from three Tokyo positions on 1928 Dec. 8, 1929 Feb. 12, and April 5. He gives the following ephemeris for this year's opposition:

1930 0^h U.T.		α h m s	δ ° ′	M_1	M_2
April	6	15 58 36	−15 36.2	14.4	15.2
	14	55 6	15 18.5	14.4	15.2
	22	50 25	14 58.5	14.4	15.2
	30	44 47	14 36.9	14.4	15.2
May	8	38 31	14 15.0	14.4	15.3
	16	32 2	13 54.0	14.4	15.3
	24	25 42	13 35.0	14.5	15.4
June	1	19 50	13 19.3	14.5	15.5
	9	15 14 47	−13 7.9	14.6	15.6

Under M_1 are given the magnitudes computed from the inverse square-ratio of the distances; under M_2 those that are found when it is assumed that the brightness varies inversely as the fourth power of the distance from the sun. It is quite pos-

sible that the comet, although very faint, might yet be recorded photographically. The opposition comes May 17.

Circular 84 of the British Astronomical Association gives a search ephemeris for PERIODIC COMET D'ARREST which comes nearest to the sun next May. The elements for this apparition have been computed by Whitwell:

$$\left.\begin{aligned} T &= 1930\ \text{May}\ 10.037\ \text{U.T.} \\ \omega &= 174^\circ\ 7'.7 \\ \Omega &= 143\ 32.7 \\ i &= 18\ 3.4 \end{aligned}\right\} 1930$$

$$\log q = 0.133202$$

$$\text{Period} = 6.6461\ \text{years}$$

The path is given with two assumed values of T differing by 8 days:

1930	T = May 6.0			T = May 14.0		
	α		δ	α		δ
0^h U.T.	h m s		° ′	h m s		° ′
Mar. 27	21 17 4		—7 31	21 0 24		—7 19
April 4	21 44 20		—6 23	21 27 20		—6 13
12	22 11 44		—5 9	21 54 32		—5 3
20	22 39 12		—3 53	22 21 54		—3 49
28	.. .. ..		.. ..	22 49 20		—2 33

Williams Bay, Wisconsin, March 24, 1930.

METEOR NOTES

By CHARLES P. OLIVIER.

This is still the poor season for meteors, and the fact is plainly indicated by the few reports that are so far at hand. It is sincerely hoped, however, that the April Lyrids, due in exactly a month, and the May Aquarids in the first ten days of May, will both be extensively observed. Each is an important stream, and fully worthy of full attention.

To date observations of 21 fireballs, sent in since our annual report was published, are at hand. Six refer to last December, and ten to February. Most were seen at sea, and several were remarkable objects. The writer has secured a few observations of the Ohio-Pennsylvania fireball of January 3, but not enough to make even an approximate determination of its path. Two supposed meteorites have been submitted, but have not been critically examined as yet.

We are also pleased to have a very valuable report of 37 telescopic meteors sent in by L. C. Peltier of Delphos, Ohio. These were observed in 1929, but came too late for the annual report. Other members of the A.A.V.S.O. who have similar observations would do us a great favor by sending us copies. Full credit will be given not only to the person but also the A.A.V.S.O. No progress has been made recently on the computations of several fireball paths for which we have the data. Those who contributed observations are asked to exercise patience, as the delay in publication has been unavoidable.

In our files we have one clipping relating to the fall of a meteorite into the ocean on February 24, 1912. It fell very close to a ship, from which the phenomenon was observed. The writer has recently been able to obtain the following account of another such occurrence from an eye witness, Mr. James Penni-

man of Philadelphia, brother of Dr. Josiah H. Penniman, Provost of the University of Pennsylvania. The latter kindly secured this note for our records:

"About 10:00 P.M. in early June, 1895, nearing Gibraltar, I was standing with a friend in the stern of the steamship, *N.G.L. Werra*, when we saw an aerolite about the size of a small Ford car drop into the sea, with a splash, several hundred yards back of the ship. It was bright and left a trail in the sky."

In a good many accounts of fireballs from ships we have statements of the object reaching or disappearing behind the horizon, but such accounts as the above are very rare. Our observers will be much interested in a review of M4, which is quite complimentary, appearing in the *Journal of the B.A.A.*, which has just come to hand. It shows that our English colleagues are keeping a close watch upon our results. Incidentally they have a small group of trained meteor observers, who are probably as skillful as any in the world. We in our turn cannot do better than study their results and methods with the closest attention.

We wish to welcome as new members the following:

Mrs. Alice J. Anderson, Box 32, Ramona, California.
Fred L. Troyer, 123 Keewatin Ave., Toronto 12, Canada.
Fred R. Conant, 210 E. 68th St., New York City.
W. P. Warner, St. Georges, South Carolina.

B. S. WHITNEY, BEAVER, OKLAHOMA.

Date		Began	Ended	Total	Meteors	F	Rate	Cor. Rate
1929 Nov.	12	14:00	15:30	90	2	0.7	1.3	1.9
Dec.	3	8:05	9:35	90	12	1.0	8.0	8.0
1930 Feb.	20	8:20	10:20	120	7	0.9	3.5	3.9
Feb.	21	10:15	11:45	90	8	1.0	5.3	5.3

F. W. SMITH, GLEN OLDEN, PENNSYLVANIA.

Date		Began	Ended	Total	Meteors	F	Rate	Cor. Rate
1930 Jan.	3	7:50	8:50	60	0	0.9	0.0	0.0
	4	8:45	9:40	55	2	1.0	2.2	2.2
	26	8:15	9:05	50	1	0.9	1.2	1.3
Feb.	18	8:00	9:00	60	0	0.9	0.0	0.0
	28	8:00	9:00	60	0	0.9	0.0	0.0

A. A. MEEKER, STATEN ISLAND, NEW YORK.

Date		Began	Ended	Total	Meteors	F	Rate	Cor. Rate
1929 Sept.	11	10:30	11:30	60	4	0.8	4.0	5.0
Oct.	6	11:00	12:00	60	1	...	1.0	...
Casuals					5			

D. F. WAUGH, TOKYO, JAPAN.

Date		Began	Ended	Total	Meteors	F	Rate	Cor. Rate
1929 Dec.	1	11:22	12:30	68	4	1.0	3.5	3.5
1930 Jan.	25	12:18	14:00	102	7	0.9	4.1	4.6

V. ANYZESKI, NEW HAVEN, CONNECTICUT.

Date		Began	Ended	Total	Meteors	F	Rate	Cor. Rate
1930 Feb.	14	6:00	7:35	95	10	0.9	6.3	7.0
	16	6:00	7:30	90	16	1.0	10.7	10.7
	17	6:15	8:15	120	13	1.0	6.5	6.5

W. B. STERNS, SANTA BARBARA, CALIFORNIA.

Date		Began	Ended	Total	Meteors	F	Rate	Cor. Rate
1929 Dec.	31	13:00	13:35	35	2	1.0	3.5	3.5
1930 Jan.	1	12:05	17:35	150	15	1.0	6.0	6.0
	2	6:00	9:35	50	0	...	0.0	...
		14:30	17:00	150	42	...	16.8	...
	3	13:12	14:27	71	4	1.0	3.4	3.4

RADIANTS BY V. ANYZESKI.

A.M.S. No.	1930	α °	δ °	Meteors	Wt.	Remarks
2140	Feb. 16	34.5	+18.	4	Good	
2141	Feb. 16	47.5	+59.5	3-5	Good	3 more Feb. 14
2142	Feb. 17	74.5	+ 5.5	6	Good	1 more Feb. 16

RADIANT BY B. S. WHITNEY.

No.	1930	α °	δ °	Meteors	Wt.	Remarks
2143	Feb. 20-21	154.	+21.	4	Good	2 on each night

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1930 March 21.

The Paragould Meteor

February 16, 16:05 (February 17, 4:05 A.M., Civil Time). Our first notice of this meteor was received from Thomas M. Galey of Independence, Kansas. It appears to have fallen at rather a low angle from the southwest, and to have been brilliant enough to attract attention in Missouri, Illinois, and even in Kansas. It burst and disappeared over a point near Paragould in northeastern Arkansas, and soon after the disappearance of the meteor, thunderous detonations aroused the community. The detonations were followed by a rumble which rolled away toward the southwest, the direction from which the meteor had come.

A few hours later a farmer, going to the field to get his horses, noticed a hole with fresh dirt thrown some thirty feet to the northeast. The meteorite apparently struck at an angle and plowed a short furrow to the northeast and downward, making a hole 34 inches deep. The following description was prepared by Mr. Stuart H. Perry, of Adrian, Michigan, who now has possession of the stone.

THE PARAGOULD METEORITE.
By Stuart H. Perry.

The meteorite measures about 17 by 10 by 9 inches, and its present weight is approximately 74½ pounds. Unknown persons chipped off perhaps 3 to 5 pounds from one of the rounded edges, so the original weight may have been close to 80 pounds. Fortunately the damage was in one spot, all the rest of the original surface being intact. The broader rounded surface was apparently the "brustseite," as that side is quite smooth and light colored, with scarcely a trace of crust and hardly a suggestion of pitting. The opposite side and the ends show a strong black crust and the flat rear side is characteristically pitted. The general color of the broken surface is a dark, very slightly greenish, gray. The smooth convex side is light gray and at a glance would be taken for an ordinary rounded boulder of light granite or diorite.

Grains of nickle-iron are thickly disseminated and there are numerous small nodules of troilite, some apparently druses rather than nodules. The ground mass of the stone is a chrondrite, showing some chrondri of large size, though most of the light colored ingredient, (apparently enstatite) appears in irregular spots suggesting a coarse porphyry, or even in places a conglomerate. There are considerable areas of a black compact nature, almost like coal though without lustre, structureless to the naked eye, but containing iron grains. These areas are not superficial, the broken surface showing that they are masses of some size included in the general ground mass. It is very solid, its coherence apparently comparable to that of an average trap rock, uniform throughout (except for the dark mater-

ial mentioned above) and without cracks or fissures.

NOTE BY C. C. WYLIE: The point of a meteorite which is foremost in its flight through the atmosphere is sometimes burned to a sort of smooth rounded nose, termed the "brustseite." The last recovery in this section of the country of meteorites generally accepted as authentic was from the fall at Tilden, Illinois, on July 13, 1927.

C. C. WYLIE.

University of Iowa, March 18, 1930.

Two Brilliant Meteors Observed in Washington

This evening (February 26, 1930) at 9:26 P.M., E.S.T., while observing variable stars, I saw an unusually brilliant and beautiful meteor. The path was from the northern part of Orion, between Sirius and Procyon, and ended somewhere south of α Hydrae. The path appeared curved like a rocket and the meteor gave the impression of moving slowly. It was much the same color as Sirius but fully twice as bright, in fact the brilliance of the meteor was such that I noticed it in the telescope although this was pointed to some distance from the path. I had plenty of time to remove my eye from the eyepiece and watch the meteor. The trail lasted about five seconds.

HUGH G. BOUTELL.

"A meteor of unusual size and brilliance was seen by many Washingtonians about 10:45 o'clock last night as it flashed across the sky from the northwest toward the southeast section of the Capital. The shooting star was said by one observer to look like 'a flaming football' and to have been visible for 10 or 15 seconds." (From the *Washington Post*, February 27, 1930.)

GENERAL NOTES

G. H. Hamilton has recently returned to Jamaica after spending several months in England.

J. Ernest G. Yalden, chairman of the Occultation Committee of the A.A.V.S.O., has recently returned to his home in New Jersey from a vacation trip in Florida.

Professor Edwin B. Frost, director of Yerkes Observatory, spent a part of the winter months in Florida. On February 28 he delivered a lecture in St. Petersburg on the subject "Your Universe."

Dr. T. J. J. See, who, as a captain in the navy, has been in charge of the naval chronometer and time station at Mare Island, California, for the past twenty-seven years, has retired from active service, having reached the statutory age of sixty-four years. (*Science*, March 14, 1930.)

Dr. Harlow Shapley, director of the Harvard College Observatory, delivered the annual Sigma Xi lectures at the University of North Carolina on February 13 and 14. The titles of the lectures were "Order Among Star Clusters and Nebulae" and "From Electrons to Galaxies." (*Science*, March 14, 1930.)

Amateur Astronomers Association of New York City presented lectures during March as follows: On March 5, "Mars" by Dr. E. E. Free; on March 19, "Time and Tide" by Professor Ernest W. Brown.

Doane College Observatory Damaged by Fire.—On the evening of February 28, Boswell Observatory, Doane College, Crete, Nebraska, was seriously damaged by fire which was caused by defective wiring. A fortunate northwest wind saved the dome, with the 8-inch refracting telescope and the transit room. The transit, which was slightly injured, is greatly prized because it was the gift of Colonel Thomas Doane and has an interesting history, being one of two instruments used in the construction of the Hoosac Tunnel. The rest of the building, including the two offices and class room, was completely destroyed.

Doane College has maintained a volunteer weather observation station for many years and was equipped with all the ordinary standard instruments for this purpose. These were all lost, also the Howard astronomical clock, a chronometer, electric bell clock, a short wave radio set, much laboratory material, and a library of about 350 books.

The loss was fairly well covered by insurance. The reconstruction of the building has already been begun and plans are made for replacing the equipment.

Auroral Display of March 11, 1930.—A very spectacular exhibition of the northern lights was seen on the night of March 11 from about 9:00 to 9:30, C.S.T., by the writer and a group of students who were assembled on the grounds of the Goodsell Observatory during the course of their regular night work. Attention was first attracted to the phenomenon by a sharp and fairly bright greenish arch or bow, bordered on the outside by the faintest suggestion of red and apparently not more than two or three degrees wide. It appeared to attain a maximum height of 15° at the north point with the feet of the arch resting on the horizon in the approximate directions NW and NE.

Shortly thereafter with the first appearance of bright green streamers in the northeast, the definite outline of the bow began to assume a "washed out" appearance, gradually merging into a shapless luminous mass which covered a considerable portion of the northern sky by the time the undulating curtains and rapidly darting streamers had worked their way to the northwest. Soon in the wake of the disappearing curtains a red smudge of color several degrees wide and 20° above the northeast horizon appeared followed by a similar blotch in the northwest until finally red, green, and yellow intermingled in a manner that is impossible to describe. In spite of a nearly full moon, the phenomenon was very marked and presented a picture of dazzling beauty. Half an hour later all that remained of the manifestation was a diffuse luminous region extending over the northern heavens nearly as high as Polaris.

Louis Berman.

Northfield, Minnesota.

Zodiacal Light Notes

From the writer's notebook the following extracts are taken for the period February 15 to February 28:

Evening Zodiacal Light. Feb. 15, 16, 17, off duty. Feb. 18, sky overcast, no observation. Feb. 19, 7:00 to 7:25, at 7:00 o'clock, sky clear, Zodiacal Light strong from horizon, covering south boundary of Square of Pegasus and extending south to Pisces, thence between Aries and Cetus, narrowing to the Pleiades where it was lost in the glare of Jupiter. At 7:25 clouds gathered quickly. Feb. 20, at 7:20 such portions of the Zodiacal Light as could be seen through scattered clouds were conspicuously luminous, more so than the neighboring Milky Way. The Zodiacal Light had a tawny tint, reminding one of billowy, brownish smoke

rising from a big fire far off. At 9:30 the whole sky was clear but it was almost impossible to make out the Zodiacal Light . . . a noticeable difference in appearance from recent evenings at this hour. Feb. 21, at 7:15 a cloudbank lay along the western horizon, otherwise the sky was clear. The Zodiacal Light was in full view as far as the Pleiades, but not so conspicuous as on recent evenings early. The lowest fourth of the Square of Pegasus was covered. Feb. 22, at 7:20 sky clear. Intensity of brightness much less than on Feb. 21. Feb. 23 and 24, sky overcast on both evenings until 11:00 P.M.; no observations. Feb. 25, at 7:30 the Zodiacal Light was observed amidst cloudbanks between the western horizon and the meridian. Such portions as were visible were normal in appearance, not conspicuously unusual as a week ago. Feb. 26, sky perfectly clear at 8:45. While not so generally bright as the Milky Way in Cassiopeia or in Puppis the Zodiacal Light made a distinct luminous arch almost to the Milky Way in Auriga. Feb. 27, at 7:25, sky clear. Along the horizon the Zodiacal Light covered the lower half of the Square of Pegasus. At 9:50, the sky still perfectly clear, the Zodiacal Light in the west was reduced to a band right down to the horizon. The eastern half of the Square of Pegasus was still in view *but was not half covered by the broad light as it had been at 7:45*. If, as is held in current theory, the broad Zodiacal Light on the horizon early in the evening is due to reflection from greater amount of material in the direction of the sun, why should it not also be visible when the same constellation is, in part, still in view two and one-half hours later? General Note: It is possible that the exceedingly strong intensity of the Zodiacal Light noted at times during the past month may be attributed to very slight general atmospheric haze.

GEGENSCHEIN AND EASTERN BANDS: Feb. 19, at 11:30, sky clear, the Gegenschein was seen surrounding Regulus and a zodiacal band towards the east from the Gegenschein was traced almost to Spica. Feb. 21, at 10:00 P.M. the Gegenschein was glimpsed, extremely faint with luminosity about central at Regulus. Shape, oval along the ecliptic narrowing to a band extending to the horizon. Feb. 25, at 9:30 the Gegenschein was seen as a faint, diffuse patch of uncertain boundary lying just south of the main body of Leo. Feb. 26, at 11:00 P.M. a zodiacal band was observed from the Gegenschein in Leo to the horizon below Spica, a band fairly even in breadth, estimated at 5°, not broad-based on the horizon as is the case with the evening Zodiacal Light on the western horizon.

The Rectory, New Market, Maryland. W. E. GLANVILLE.

A Paradox in Astronomy

Recently I read an article, in which a popular writer argues that Ptolemy could not be the original founder of his star catalogue. His argument is based on the fact that Achernar, α Eridani, is missing in the star catalogue of Ptolemy. The whole article being devoted to the description of various stars, the style of the description reminded me of "Star-names and their Meanings" by Richard Hinckley Allen, as the source. So referring to the 1899 edition of the above-mentioned book, I found, on page 218, entirely the same argument as follows:

> "Ptolemy did not mention it, although he could have seen it from the latitude of Alexandria, 31° 11'.—a fact, among others, which argues that his catalogue was not based upon original observations, but drawn from the now lost catalogue of Hipparchos, compiled at Rhodes, more than 5° further north, from which place Achernar was not visible."

I did not know that there has been proposed such an argument and also I do

not know whether discussions have already been raised on this subject somewhere. But it will be easily seen, after short consideration, that the argument is not correct.

The fallacy comes from the fact that he did not take into account the effect of the precession. Let us now take out the position of α Eridani from *Boss' Preliminary General Catalogue*:

R.A.	$1^h\,33^m\,59^s.463$	$+2^s.2391$	$-^s.0130$	$+^s.018$	$+^s.0111$	-2 } Equinox
Decl.	$-57°\,44'\,40''.97$	$+18''.355$	$-''.139$	$-''.07$	$-''.029$	-1 } 1900.0

It shows that he could have seen it at Alexandria, if the star had been as far from the South Pole as it now is.

Although the biography of Ptolemy is not accurately known to us, it will be safe to assume that he did not survive the year 200 A.D., and since the effect of the precession brings back the star nearer to the South Pole when we go back to the past, I computed the position of the star at 200 A.D. as follows:

R.A.	$0^h\,25^m\,19^s.0$	} Equinox
Decl.	$-66°\,52'\,26''$	} 200.0

From the above value of the declination, we can see that Ptolemy was not able to observe the star Achernar in any way, even though he lived far south from Alexandria.

Joe Ueta.

Kyoto University Observatory, 1930 February.

Paraselenae Observed in New Zealand

The occurrence of paraselenae or mock moons is always a sufficiently rare phenomenon to excite attention, but the visibility of the phenomenon in such a low latitude as that of Auckland, New Zealand, (36° 50′ South) must be rare indeed. It is, therefore, not surprising that the true nature of the phenomenon witnessed on the night of August 17 last was not at first apparent.

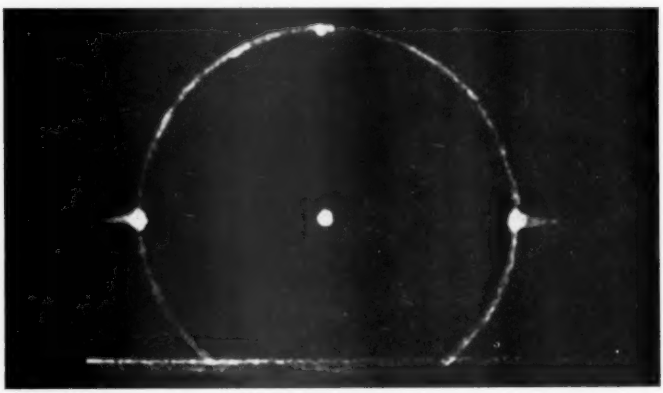


Illustration of Paraselenae.

On going out of doors at 2:00 A.M. the sky was seen to be covered with a light, misty cloud showing no movement and probably at a very high altitude. Through this the moon shone practically undimmed in brilliancy. At the time the

paraselenae were strikingly evident, my attention being drawn to the right hand mock moon as soon as I looked at the sky. Thinking at first that some cloud was peculiarly reflecting the moon's light I did not pay much attention to the matter, but as the phenomenon persisted I began to wonder whether some bright nova or comet was hidden behind the mist at this spot.

When a clear view of the sky was obtainable I had made up my mind to test the possibility of this being a manifestation of mock moons, and my suspicions were justified, as at an equal distance on the other side of the moon another bright patch was seen, the two patches being on a halo which had the moon for center. The accompanying illustration shows how the phenomenon appeared to me at the time. The mock moons appeared of the same apparent diameter as the real moon, but were hazy and ill defined. They were situated on the halo, level with the real moon. The halo was bright but showed no colour. It was 47° in diameter. The mock moons possessed faint comet-like tails which pointed directly away from the real moon.

About 2:30 A.M. I examined the phenomenon with binoculars, but the light must have been extremely faint, as all detail was lost in the small magnification (power six). Clouds then came up and put an end to a most interesting spectacle.

The following meteorological conditions prevailed at the time: An anticyclone was passing away eastwards and a cyclone was approaching from the southwest. The barometer was falling. The previous day had been fine and splendidly clear, the following day was cloudy and threatening.

Although text-books have little to say concerning the cause of paraselenae, it appears that the phenomenon is due to refraction from ice-crystals in high-altitude cirrus clouds, probably affected by the impingement of two air streams, hot and cold, rare and dense. It would be interesting to know whether this phenomenon has been previously observed in a similarly low latitude.

R. A. McINTOSH, F.R.A.S.

A Correction and An Apology

Due to a misunderstanding or an unintentional misinterpretation of the situation, Mr. David B. Pickering, the author of the paper entitled The Astronomical Fraternity of the World, (Part VI), published in the April issue of POPULAR ASTRONOMY was led to make certain statements, which, according to a letter received from Dr. Ernst Dittrich, Director of the Observatory Stara Dala, formerly O'Gyalla, do not accurately represent the facts. In particular, the statement, found on page 200, "Not a single instrument, not a book from the library, was left in the possession of the new Hungarian state," Dr. Dittrich says is inaccurate, because, as he states, a substantial part of the equipment of O'Gyalla was transferred to Pesth before the arrival of the Czechoslovakian army. Secondly, the statement on page 201, ". . . which Observatory (O'Gyalla) up to that time (1927), had not again been put into service," is in error, Dr. Dittrich asserts, and substantiates his assertion by mentioning the facts that the Government had furnished funds for repairs and rehabilitation and also has purchased a 60-cm reflector from Zeiss.

Both Mr. Pickering and the editor of POPULAR ASTRONOMY are eager to make amends for any erroneous impressions which may have been created. Therefore, they gladly call attention to the corrections noted above, and make their apology to those whose motives and conduct may in any way have been unwittingly misrepresented.

BOOK REVIEWS

A Source Book in Mathematics, by David Eugene Smith. (McGraw-Hill Book Co., New York City. 701 pages. $5.00.)

It is difficult to imagine a more useful and more stimulating volume for any one who has an interest in the study of mathematics in general than the volume described by this title, the second volume in the series of Source Books in the History of the Sciences under the general editorship of Dr. Gregory D. Walcott. It is stated in the author's preface that the plan of the series limited the work to a consideration of sources originating since the advent of printing and before the close of the nineteenth century, a period of about four and a half centuries. Within these limits, however, there is an abundance of material of a wide variety. The realm of mathematics in this treatise is divided into five fields as follows: I.—The Field of Number. II.—The Field of Algebra. III.—The Field of Geometry. IV.—The Field of Probability. V.—The Field of the Calculus, Functions, Quaternions. In these several fields quotations are made from the works of 25, 16, 30, 6, and 13 writers, respectively. Among these one finds the names of all of the great contributors to the very extensive development which the science of mathematics had in this period.

The experience of the reviewer has been that, whenever he takes up this volume and opens it at random, he immediately finds himself in the midst of a most entrancing and most illuminating presentation.

The tone of the work throughout portrays the unusual capabilities of the author for such an undertaking.

A library or any collection of mathematical books will greatly enhance its usefulness by the addition of this volume.

Publications Received.—The publishers of POPULAR ASTRONOMY hereby acknowledge the receipt of the following named publications and express their great appreciation of the courtesy shown on the part of those who have sent them.

1. Line Intensities in Nebular Spectra, by H. H. Plaskett. (Publications of the Astrophysical Observatory, Vol. IV, No. 14.)
2. Wave Lengths and Atomic Levels in the Spectrum of the Vacuum Iron Arc, by Keiven Burns and Francis M. Walters, Jr. (Publications of the Allegheny Observatory, Vol. VI, No. 11.)
3. The Radiation of the Planet Earth to Space, by G. G. Abbot. (Smithsonian Miscellaneous Collections, Volume 82, No. 3.)
4. Radial Velocities of 500 Stars of Spectral Class A, by Edwin B. Frost, Storrs B. Barrett and Otto Struve. (Publications of the Yerkes Observatory, Volume VII, Part 1.)
5. Neue Untersuchungen im Saturnsystem III. Die Beobachtungen in Johannesburg 1926-1928, by Georg Struve. (Veroffentlichungen der Universitätssternwarte zu Berlin-Babelsberg, Band VI, Heft 3.)
6. Absolute Deklinationen Von 2261 Fundamentalsternen für das Aquinoktium 1925 Nach Beobachtungen am Vertikalkreise in den Jahren 1916-1927, by L. Courvoisier. (Veroffentlichungen der Universitätssternwarte zu Berlin-Babelsberg, Band VII, Heft 4.)
7. Die Isophoten Wellenlängen der Integralhelligkeiten der Fixsterne in Rechnung und Beobachtung, by A. Brill. (Veroffentlichungen der Universitätssternwarte zu Berlin-Babelsberg, Band VII, Heft 5.)